Single Aisle
TECHNICAL TRAINING MANUAL
CMQ Intra Family - SA Family IAE V2500 or CFM 56 to A319/320/321 PW 1100G - T1/T1+T2
POWER PLANT PW 1100G

POWER PLANT PW 1100G

70 POWER PLANT PW1100G PRESENTATION (1)

INTRODUCTION

The PW1100G engine is an axial flow, dual-rotor, geared fan, variable stator, ultra high bypass ratio power plant. The PW1100G engines power the A319, A320 and A321 aircraft of the Single Aisle New Engine Option (NEO) family. PW1100G engines are available in several thrust ratings. The geared turbo fan engine reduces fuel consumption, air pollution and noise.
Each engine comes with a Data Storage Unit (DSU) which is connected onto the Electronic Engine Control (EEC). It provides engine parameters, thus the possibility of changing the thrust rating.

A/C	A/C MODEL	ENG MODEL	MTO
A319	A319-171	PW1124G-JM	24.5 klbs
A319	A319-172	PW1122G-JM	22.9 klbs
A319	A319-173	PW1127G-JM	26.8 klbs
A320	A320-271	PW1127G-JM	26.8 klbs
A320	A320-272	PW1124G-JM	24 klbs
A321	A321-271	PW1133G-JM	32.7 klbs
A321	A321-272	PW1130G-JM	29.7 klbs

MTO: Maximum Take-off

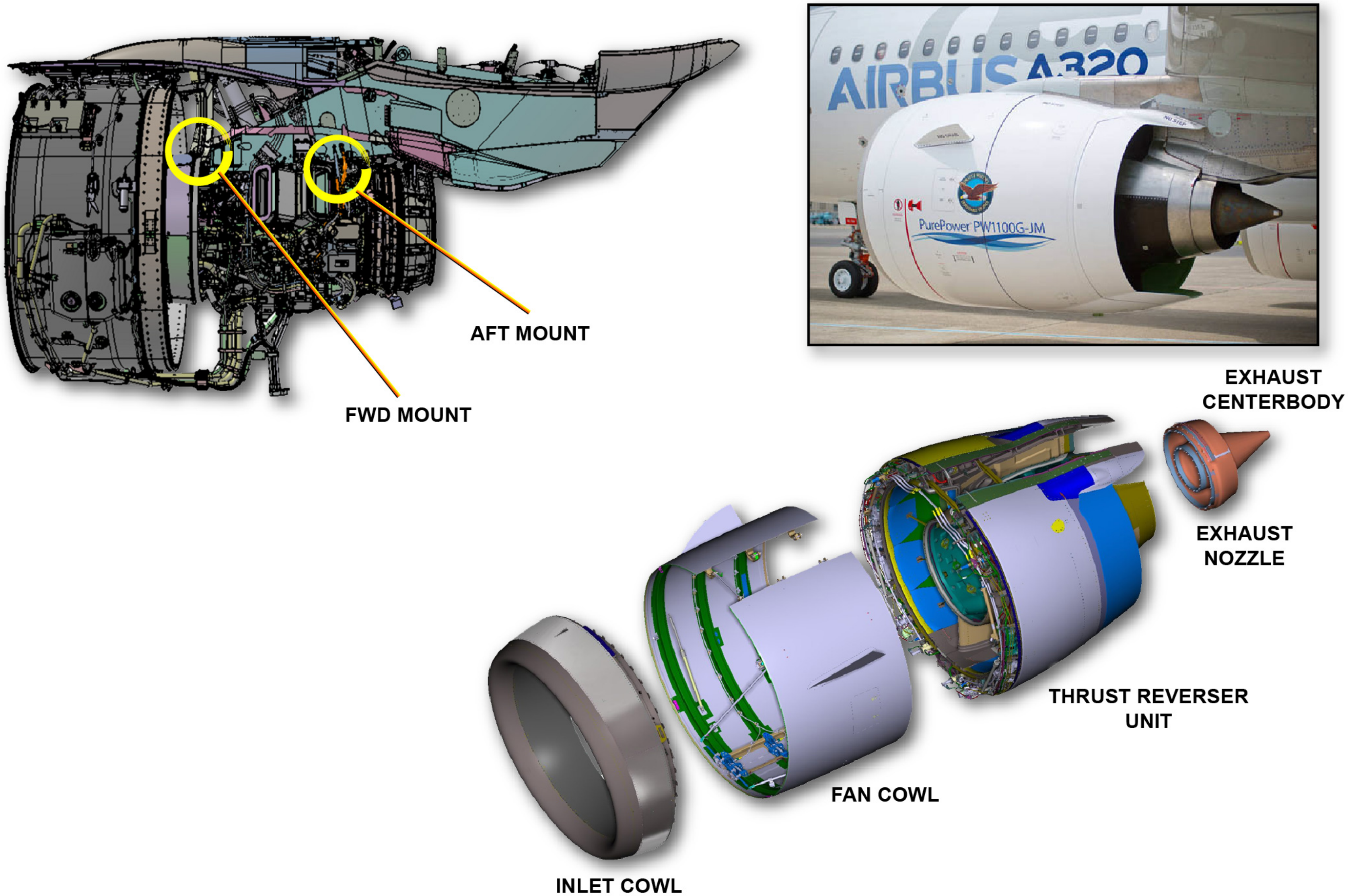
PW1127G-JM

INTRODUCTION

70 POWER PLANT PW1100G PRESENTATION (1)

INSTALLATION

The power plant installation includes the engine, the engine inlet cowl, the fan cowls, the thrust reverser assemblies and the exhaust nozzle and centerbody.
The engine is attached to the pylon by forward and aft mounts to transmit the engine and thrust loads. The pylon connects the engine to the wing structure. The forward engine mount is located on the Compressor Intermediate case. The rear engine mount is located on the Turbine Exhaust Case.

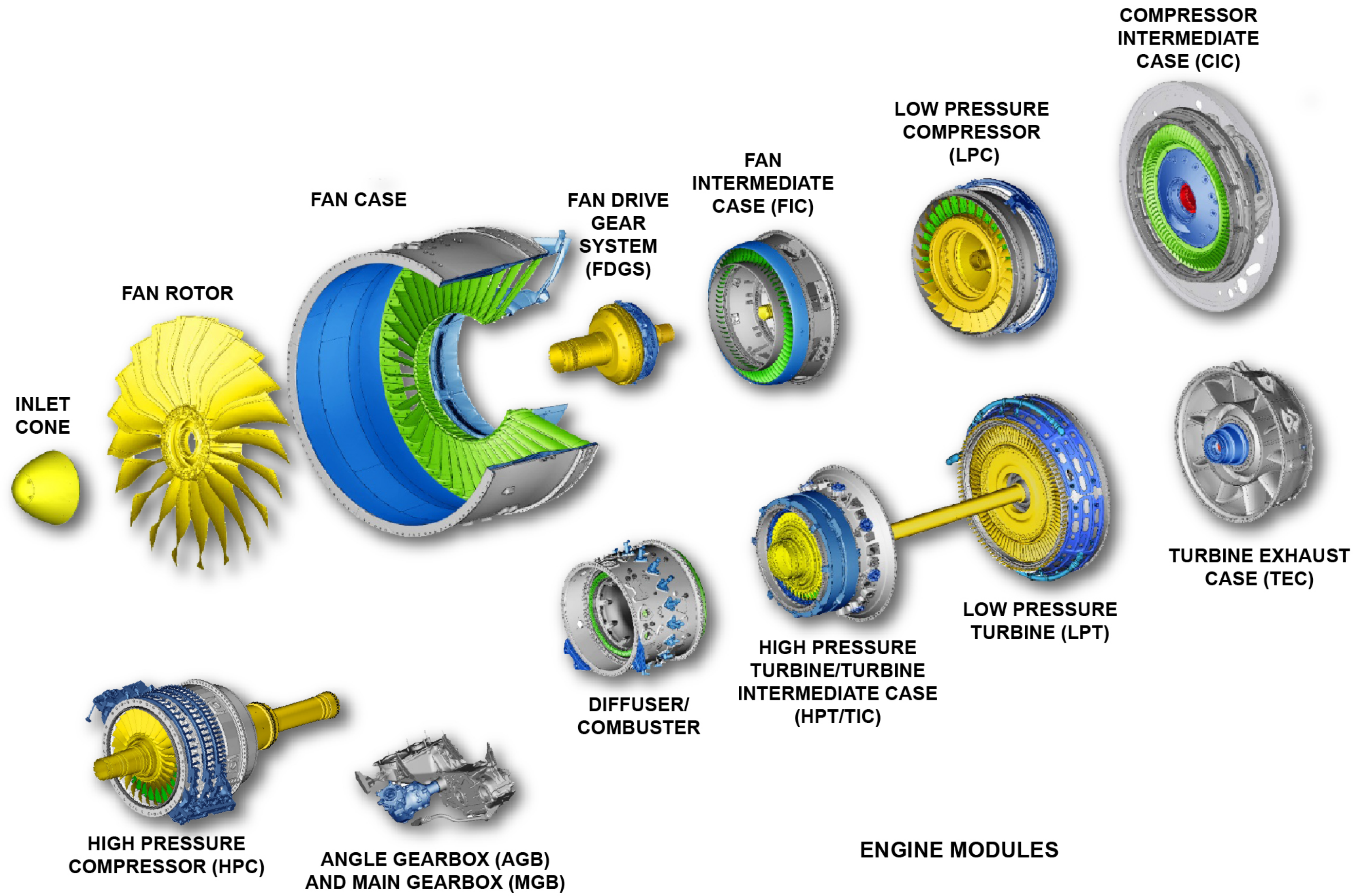


INSTALLATION

70 POWER PLANT PW1100G PRESENTATION (1)

MODULAR CONCEPT

The PW1100G engine assembly modules are:
- Fan rotor
- Fan and Intermediate Case
- Fan Drive Gear System (FDGS)
- Low Pressure Compressor (LPC)
- Compressor Intermediate Case (CIC)
- High Pressure Compressor (HPC)
- Gearboxes under engine core
- Diffuser and combustor
- High Pressure Turbine (HPT)
- Turbine Intermediate Case (TIC)
- Low Pressure Turbine (LPT)
- Turbine Exhaust Case (TEC).



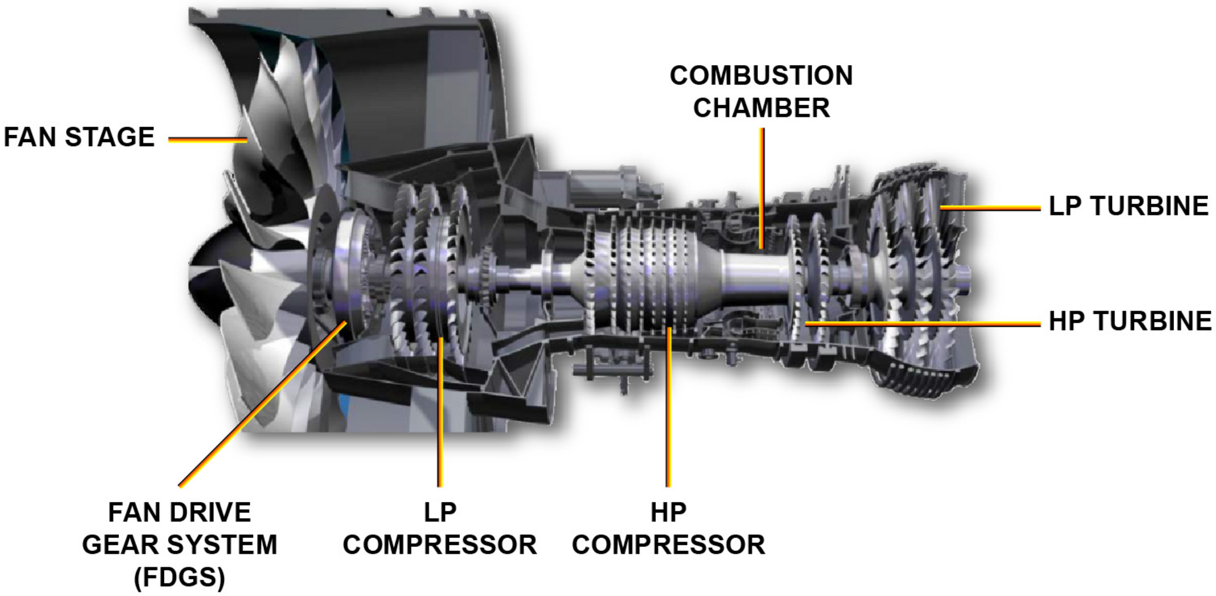
MODULAR CONCEPT

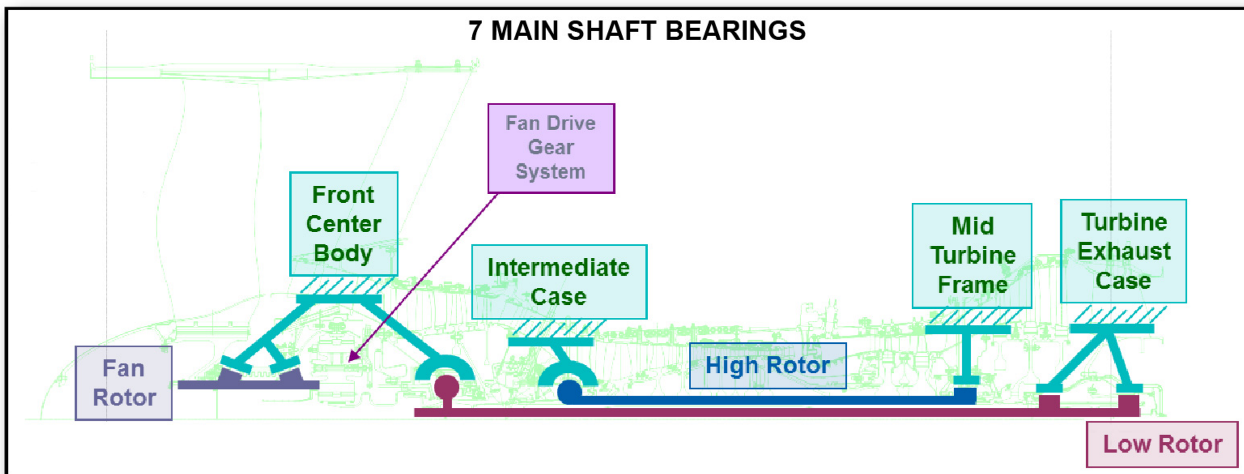
70 POWER PLANT PW1100G PRESENTATION (1)

MODULAR CONCEPT (continued)

LP ROTOR, HP ROTOR AND COMBUSTION CHAMBER

The Low Pressure (LP) rotor comprises a fan driven by the FDGS, the Low Pressure compressor and the LP shaft, all driven by the LP turbine. The speed of the LP rotor is indicated on the ECAM as N1.
The fan supplies most of the engine thrust. The air produced by the fan is known as secondary airflow or bypass airflow.
To improve the propulsive efficiency and fuel consumption, the FDGS reduces the fan speed thanks to reduction gear mechanism.
The 3-stage Low Pressure (LP) compressor supplies air to the engine core. This is primary airflow. The LP compressor rotates at the same speed as the 3 stage LP turbine.
The High Pressure (HP) rotor is made up of 8 stage HP compressor driven by two stage HP turbine. The speed of the HP rotor is indicated on the ECAM as N2.
The LP and the HP rotors are supported by roller and ball bearings which are lubricated and cooled.
The annular combustion chamber is installed between the HP compressor and HP turbine.
It has ports for 18 fuel nozzles and 2 igniter plugs.





MODULAR CONCEPT - LP ROTOR, HP ROTOR AND COMBUSTION CHAMBER

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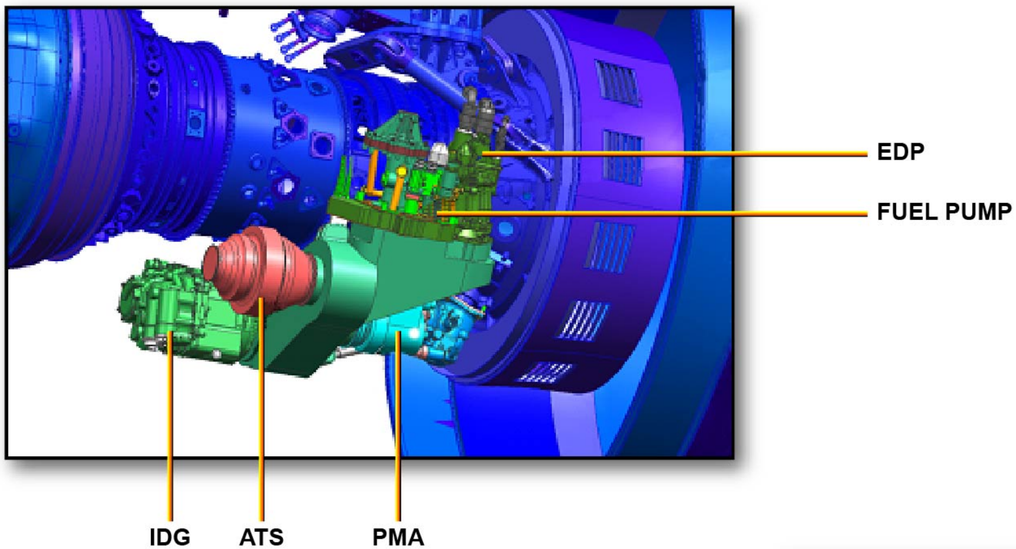
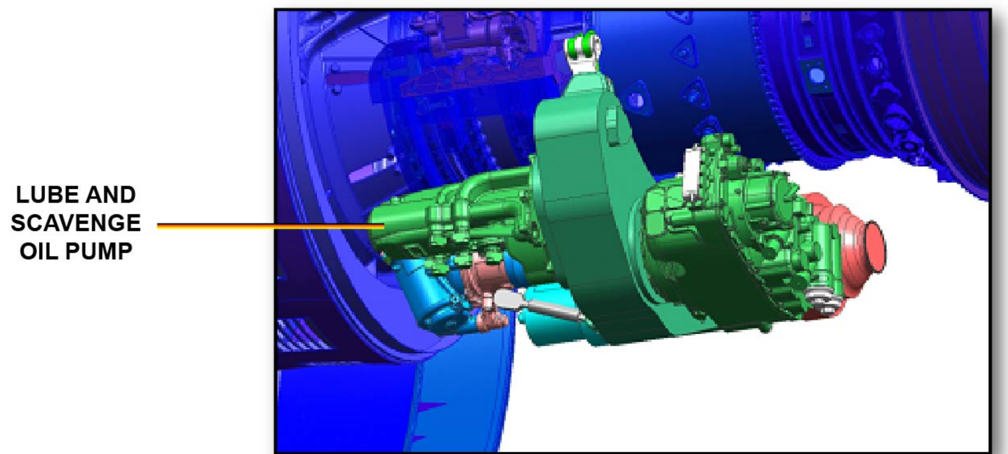
70 POWER PLANT PW1100G PRESENTATION (1)

MODULAR CONCEPT (continued)

TRANSFER & ACCESSORY GEARBOXES

The accessory gearbox is installed under the core engine and is driven by the HP rotor through the Angle gearbox.
The fuel pumps, oil pumps, hydraulic pump, Integrated Drive Generator (IDG) and FADEC alternator are all driven by the gearbox.
During engine starting, the air turbine starter rotates the HP compressor through the gearboxes.





ATS: Air Turbine Starter
EDP: Engine Driven Pump
IDG: Integrated Drive Generator
PMA: Permanent Magnet Alternator

MODULAR CONCEPT - TRANSFER & ACCESSORY GEARBOXES

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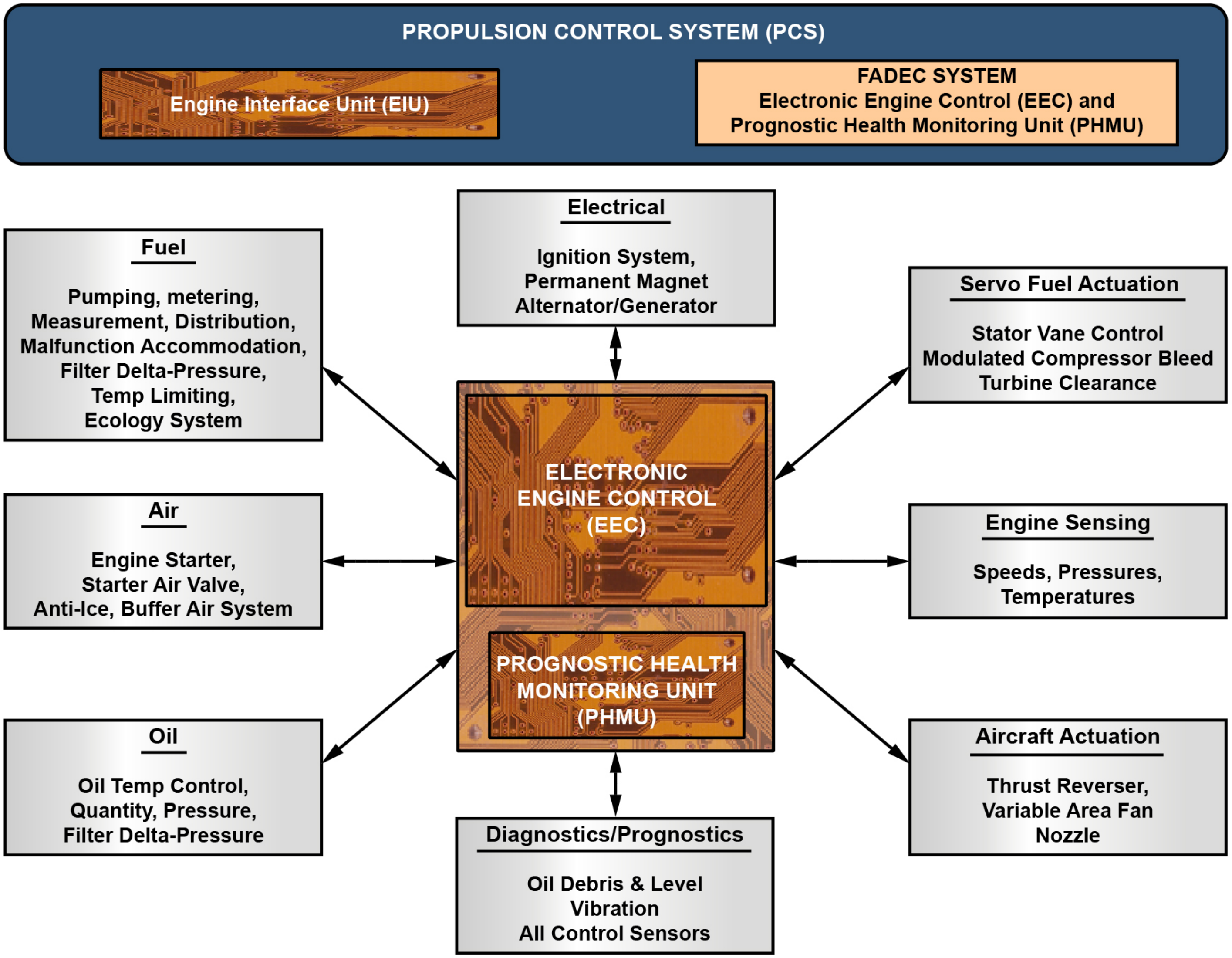
70 POWER PLANT PW1100G PRESENTATION (1)

PROPULSION CONTROL SYSTEM (PCS)

The Propulsion Control System (PCS) regroups the following subsystems:
- The FADEC system consists of an Electronic Engine Control (EEC) and a Prognostic Health Monitoring Unit (PHMU),
- The Engine Interface Unit (EIU).

In order to increase engine reliability and efficiency, the FADEC gives the full range of engine control to achieve steady state and transient engine performances when operated in combination with aircraft subsystems.
The EEC controls the operation of the following:
- Engine control for thrust setting in Manual and Auto thrust Modes,
- Thrust Control Malfunction protection,
- Engine airflow control,
- Combustor fuel metering valve,
- Control and monitoring sensing,
- Ignition and starting systems,
- Command and monitoring of the thrust reverser system,
- Fault detection, isolation, annunciation and transmission to the A/C (BITE).

When the engine is running, power for FADEC operation is supplied by a dedicated alternator driven by the gearbox.
The PHMU interfaces with the EEC. It monitors the Engine vibrations and the Oil debris.



PROPULSION CONTROL SYSTEM (PCS)

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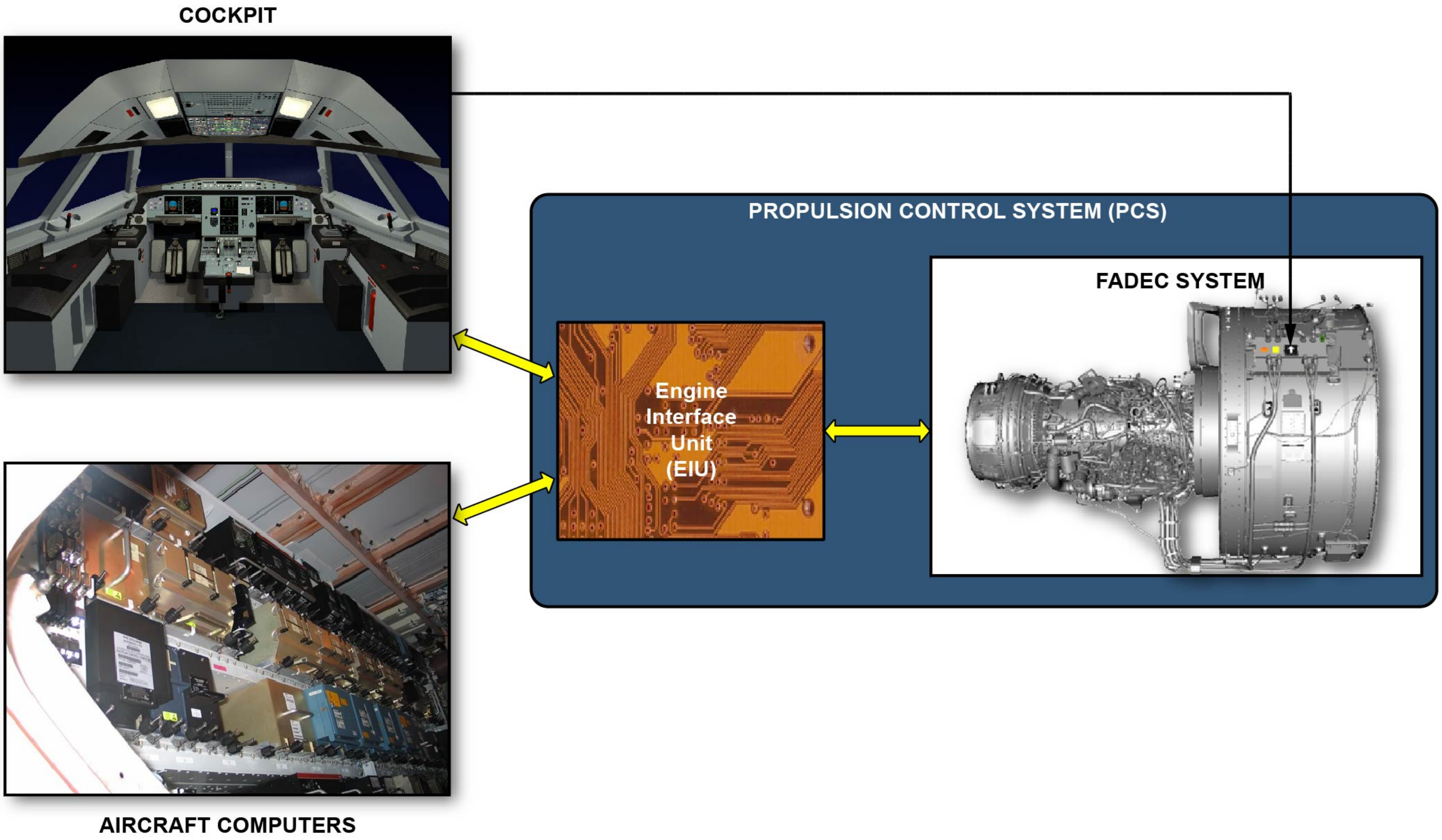
70 POWER PLANT PW1100G PRESENTATION (1)

EIU

The EIU is an interface concentrator between the airframe and the corresponding engine. Two EIUs are installed in the A/C. EIU-1 interfaces with Engine 1 and EIU-2 interfaces with Engine 2.
The main functions of the EIU are:
- To concentrate data from cockpit panels and different aircraft systems to the associated EEC on each engine,
- To ensure the segregation of the two engines,
- To give to the airframe the necessary logic and information from engine and to other systems (APU, ECS, Bleed Air, Maintenance),
- To give to the FADEC system some necessary logic and information from systems (example: flight/ground status).

The Fan Cowl latches of the A320 NEO are monitored by proximity switches which send their position signals to the EIU.
The EIU transfers signals to the FWC for associated cockpit warnings based on specific logic conditions.

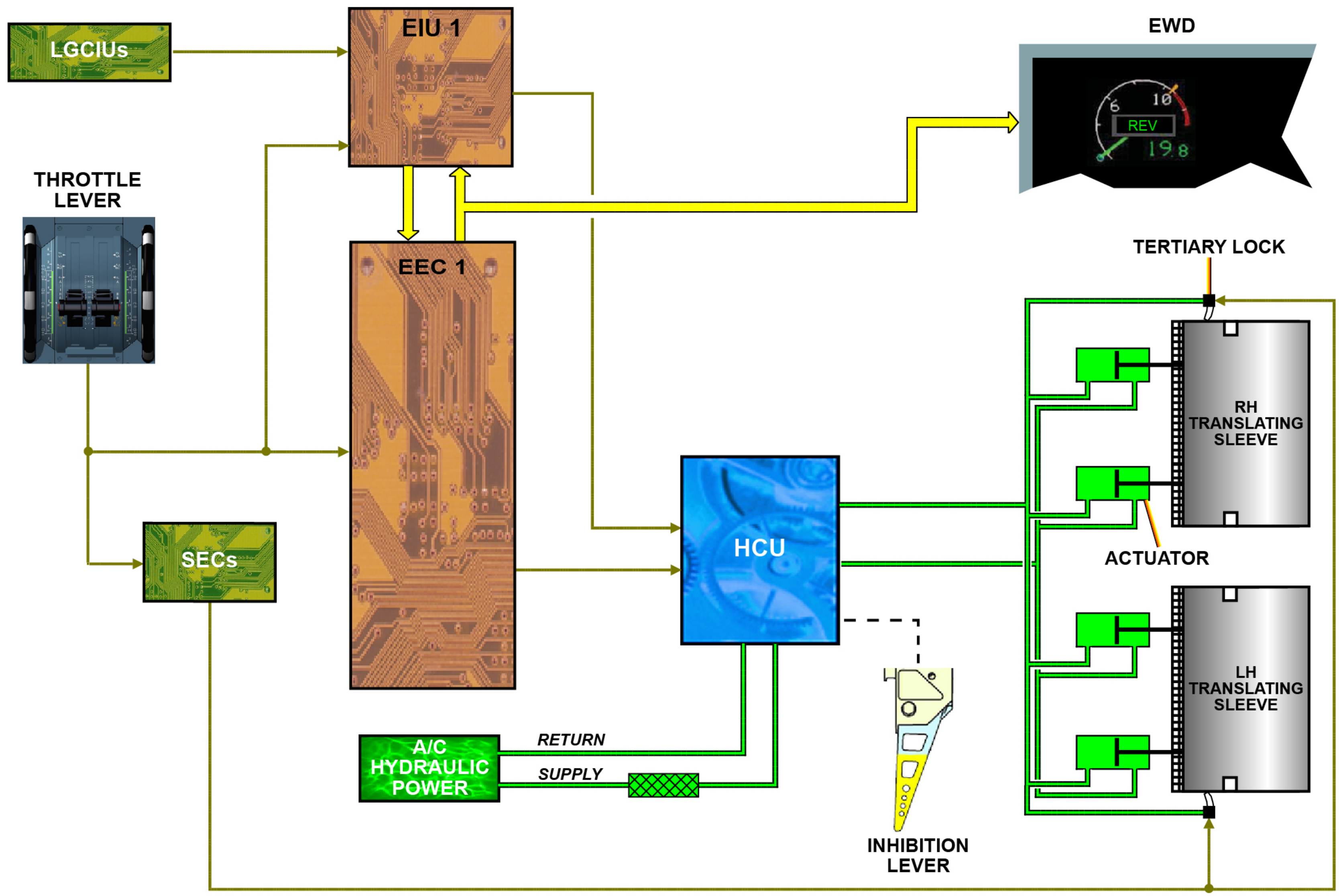

COCKPIT
PROPULSION CONTROL SYSTEM (PCS)
FADEC SYSTEM
Engine Interface Unit (EIU)
AIRCRAFT COMPUTERS

EIU

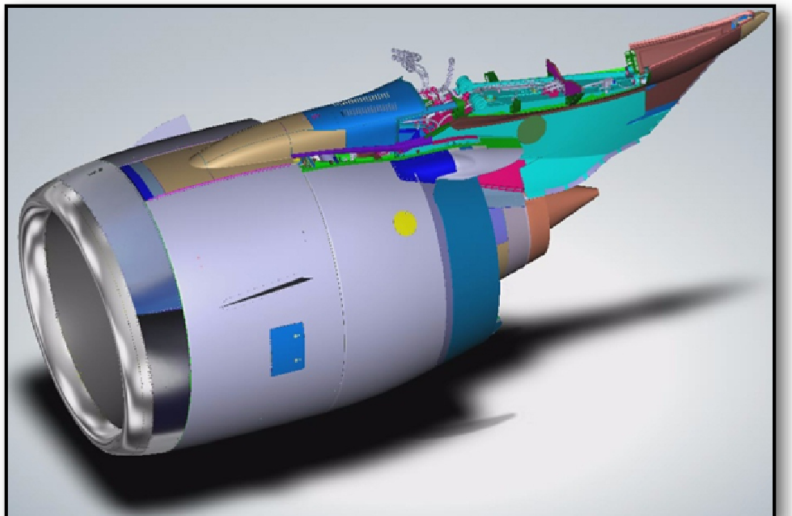
70 POWER PLANT PW1100G PRESENTATION (1)

THRUST REVERSER SYSTEM

The flight crew manually selects reverse thrust by lifting the latching levers on the throttle control levers. The thrust reverser system comprises of 2 translating sleeves, 10 blocker doors with cascade vanes per engine.
The EEC in accordance with the EIU control valves inside the Hydraulic Control Unit (HCU) for deploy and stow sequences.
HCU supplies hydraulic power to operate thrust reverser actuators.
The SEC computers authorize unlocking of Tertiary Locks.
For maintenance or dispatch the reverser system can be inhibited.
Reverse thrust is only available on the ground.



THRUST REVERSER SYSTEM



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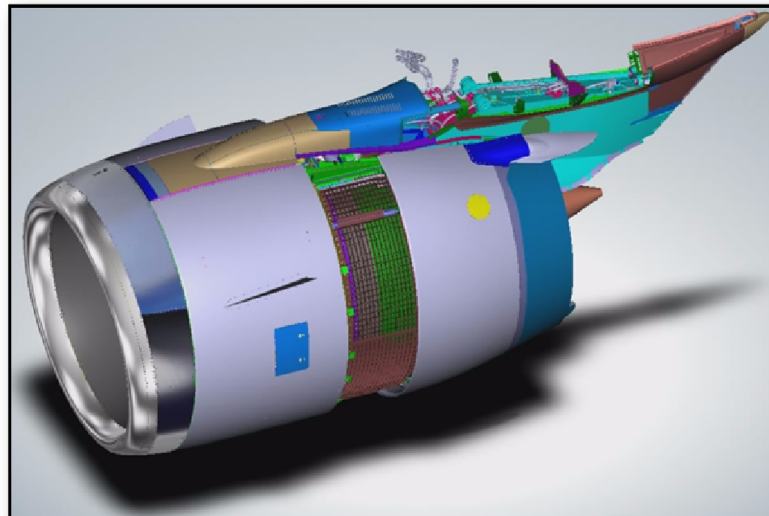

TR DEPLOYED

THRUST REVERSER SYSTEM

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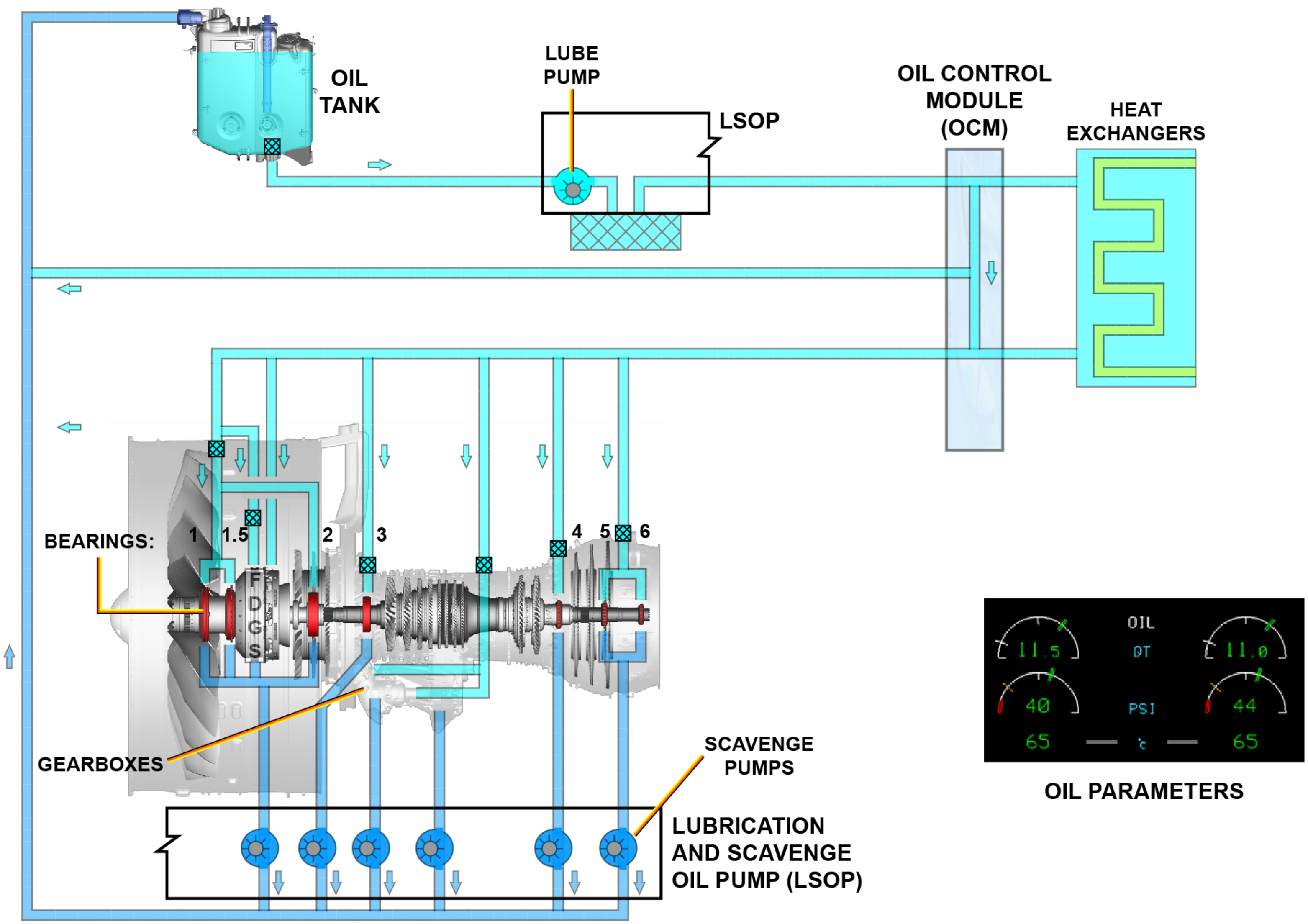
70 POWER PLANT PW1100G PRESENTATION (1)

OIL SYSTEM

The oil system comprises of an Oil tank, oil pumps located within the Lubrication and Scavenge Oil Pump unit (LSOP), Oil Control Module (OCM), filters and heat exchangers.
The oil is used to lubricate and cool the bearings, the Fan Drive Gear System (FDGS), gearboxes and accessories.
The supply oil, cooled oil and the return oil parameters are monitored for ECAM warnings and indications.



OIL SYSTEM

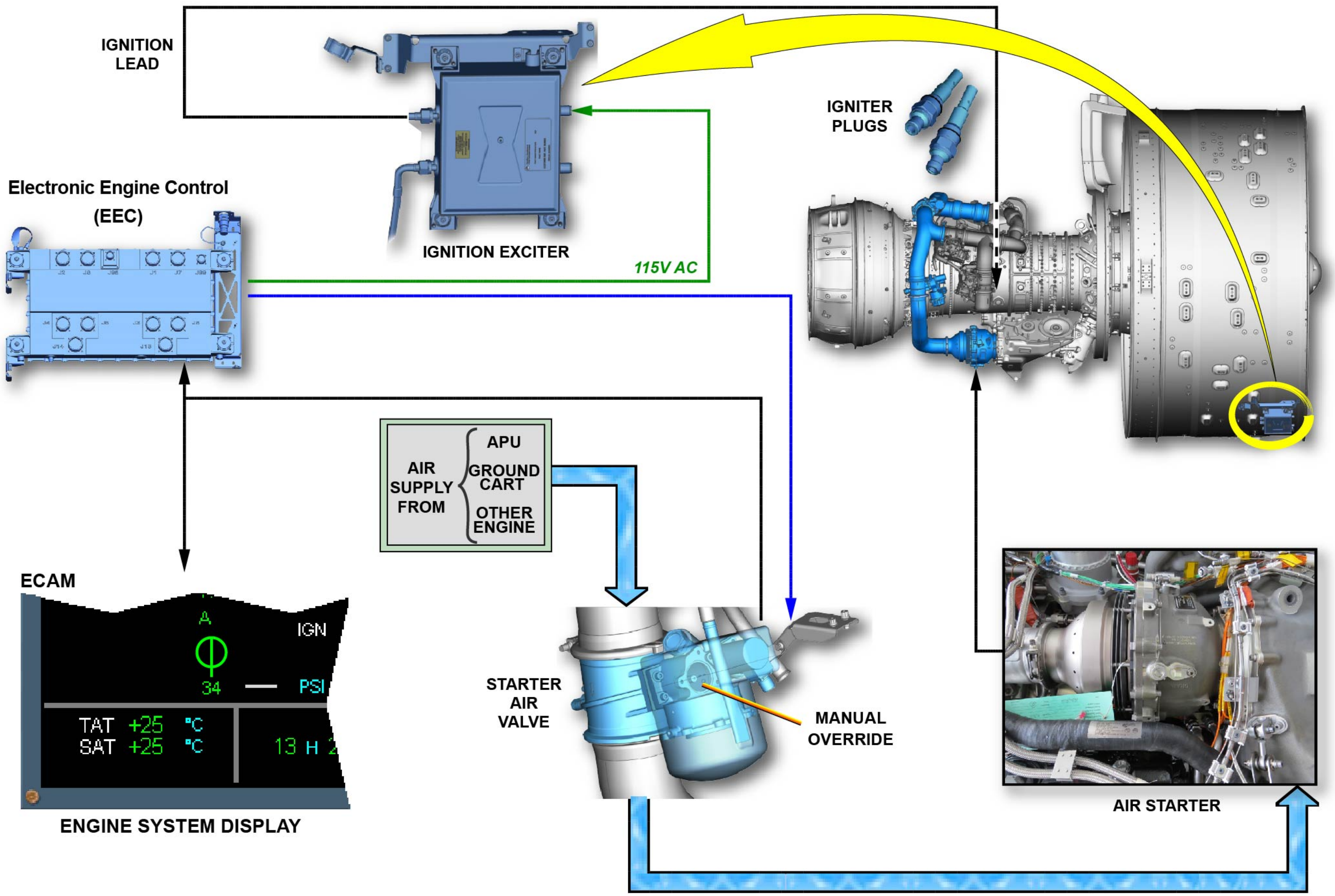
UJ515241 - U08T0MEP - UM70PZPW1100G07

70 POWER PLANT PW1100G PRESENTATION (1)

IGNITION AND STARTING SYSTEMS

The Engine starting system is used for normal engine starts, in-flight restarts and ground monitoring.
The EEC controls the Starter Air Valve (SAV) to supply air to the Starter for initial N2 rotation.
Then the EEC controls the ignition for combustion starting.
Parameters are displayed on the ECAM during the sequence.

NOTE: Note: The SAV has a manual override function.



IGNITION AND STARTING SYSTEMS

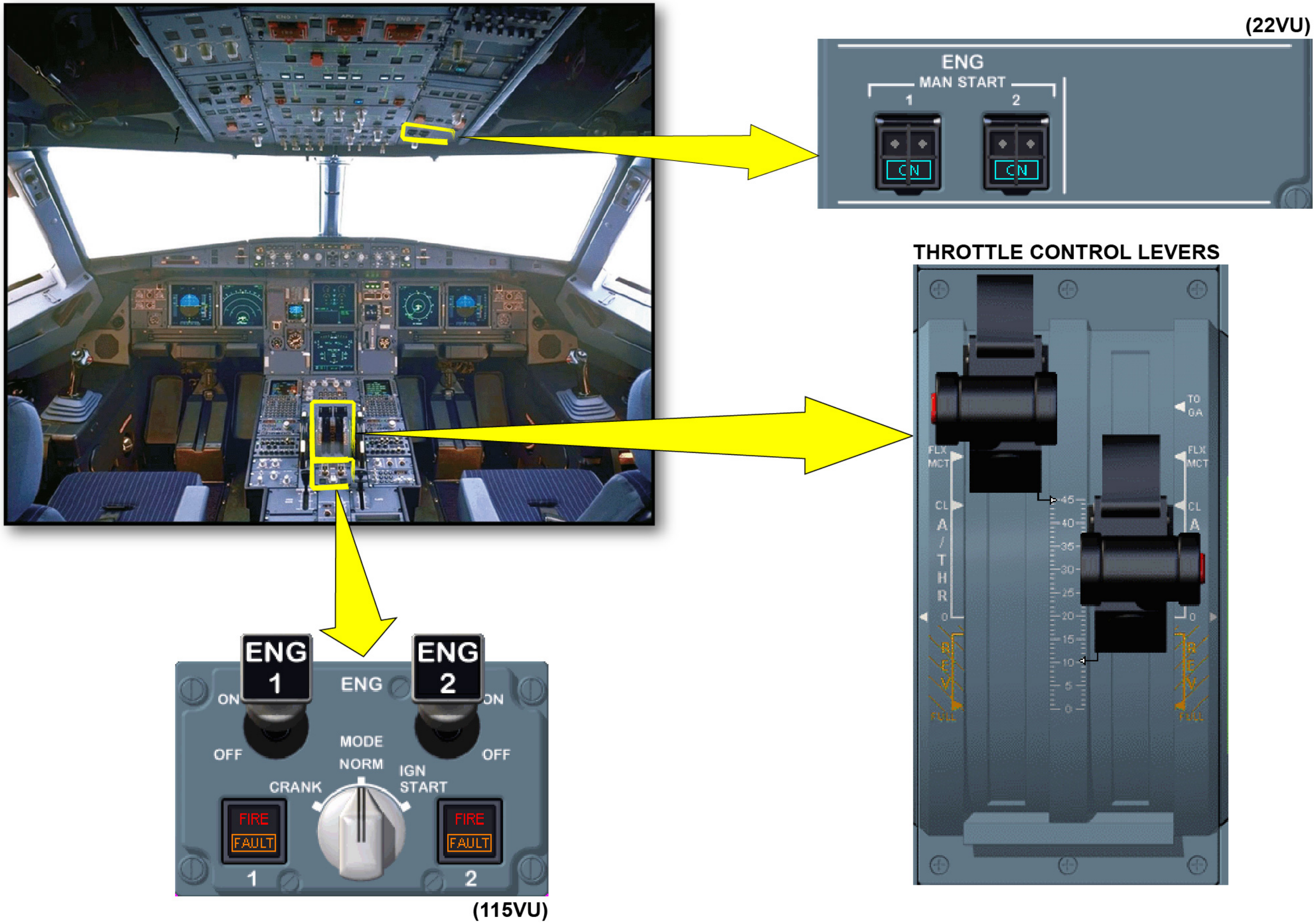
70 POWER PLANT PW1100G PRESENTATION (1)

CONTROL AND INDICATING

This section will highlight the control panels and indications for the engines.

CONTROL PANELS

The engines are controlled by throttle control levers which are installed on the center pedestal. They can only be moved manually.
For reverse thrust operation, two latching levers let the throttle control levers move rearward into the reverse thrust section.
The A320 family aircraft normally operate in the auto thrust mode, when in flight.
The autothrust can be disconnected with an instinctive disconnect pushbutton (2 red buttons are installed on the outside of the lever). This lets the engines be controlled in manual thrust mode.
The controls for engine starting and shutdown are installed on the center pedestal immediately behind the throttle control levers.
The engine MAN START switches are installed on the overhead panel. These switches are used to start an engine during a manual start procedure. They are also used during a dry or wet motoring procedure.



CONTROL AND INDICATING - CONTROL PANELS

UJ515241 - U08T0MEP - UM70PZPW1100G07

70 POWER PLANT PW1100G PRESENTATION (1)

CONTROL AND INDICATING (continued)

ECAM ENGINE

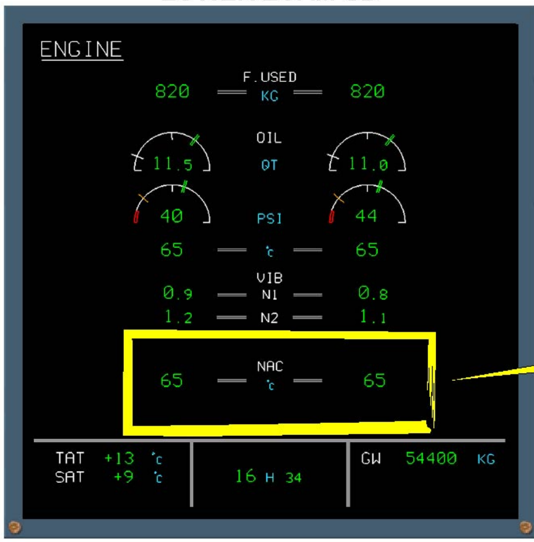
The engine primary parameters are permanently displayed on the upper ECAM.
The engine secondary parameters are presented on the lower ECAM ENGINE page when selected or displayed automatically during engine start or a fault.
Some engine parameters are permanently displayed on the CRUISE page in flight.

UPPER ECAM EWD

DURING REVERSE THRUST

CRUISE PAGE

LOWER ECAM SD



DURING ENGINE START

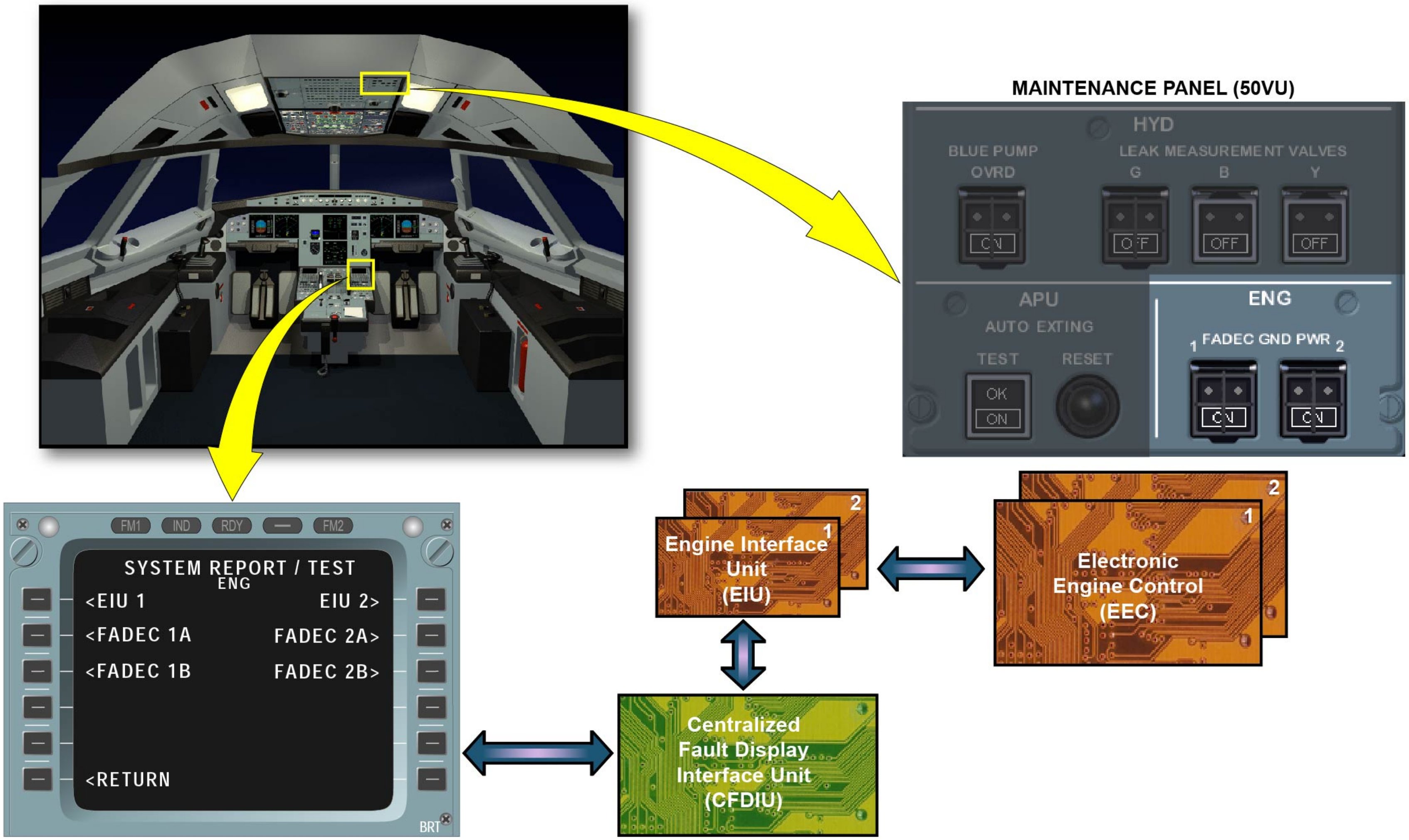
CONTROL AND INDICATING - ECAM ENGINE

70 POWER PLANT PW1100G PRESENTATION (1)

MAINTENANCE/TEST FACILITIES

On the maintenance panel, the ENG FADEC GND PWR permits to supply the FADEC system for maintenance tasks, when the engines are not running.
The MCDU is used to do PCS tests and for trouble shooting monitored components (computers, sensors, actuators).

UJ515241 - U08T0MEP - UM70PZPW1100G07

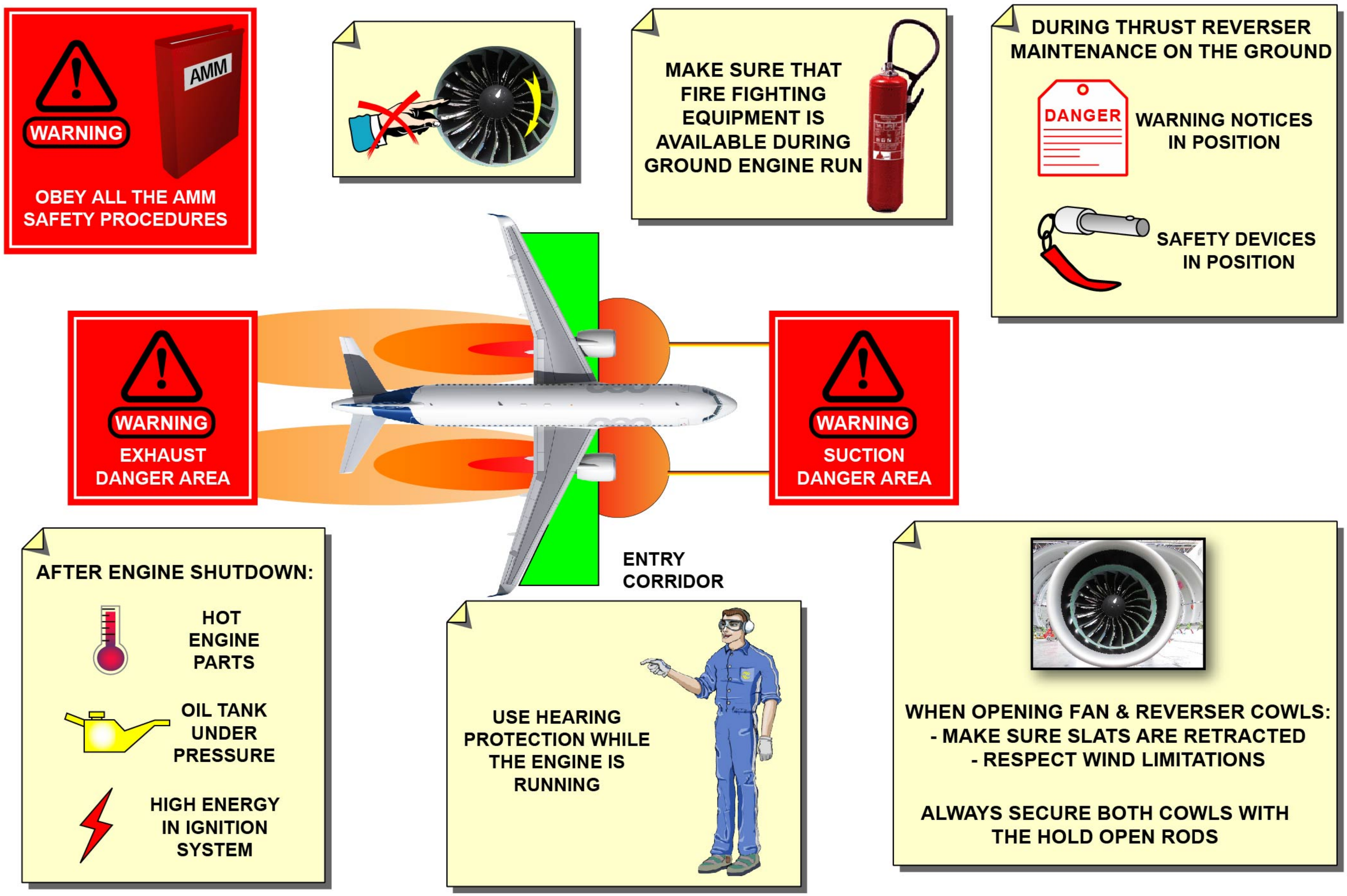


MAINTENANCE/TEST FACILITIES

70 POWER PLANT PW1100G PRESENTATION (1)

SAFETY PRECAUTIONS

When you work on aircraft, make sure that you obey all the Aircraft Maintenance Manual (AMM) safety procedures.
This will prevent injury to persons and/or damage to the aircraft. Here is an overview of main safety precautions related to the engines.
Make sure that all engine danger areas are as clear as possible to prevent damage to the engine, the aircraft or persons in the area.
Be careful: The entry corridor will be closed when the engine power is above the minimum.
Make sure that you have fire-fighting equipment available.
Do not try to stop the fan from turning by hand.
After engine shutdown, let the oil tank pressure bleed off for a minimum of 5 minutes before you remove the tank filler cap. If you do not, pressurized oil can flow out of the tank and cause dangerous burns.
The engine ignition system is an electrical system with high energy. You must be careful to prevent electrical shock. Injury or death can occur. Do not do maintenance on the ignition system while the engine operates.
Make sure that the engine shutdown occurred more than 5 minutes ago before you continue with the maintenance procedure.
Make sure that the thrust reverser is deactivated during maintenance. If not, the thrust reverser can operate accidentally and cause injury to personnel and/or damage to the reverser.
When opening the engine cowls:
o Respect the wind limitations and the opening/closing sequence,
o Always secure cowls with the hold-open rods,
o Make sure that the slats are retracted and install a warning notice to prevent slat operation.

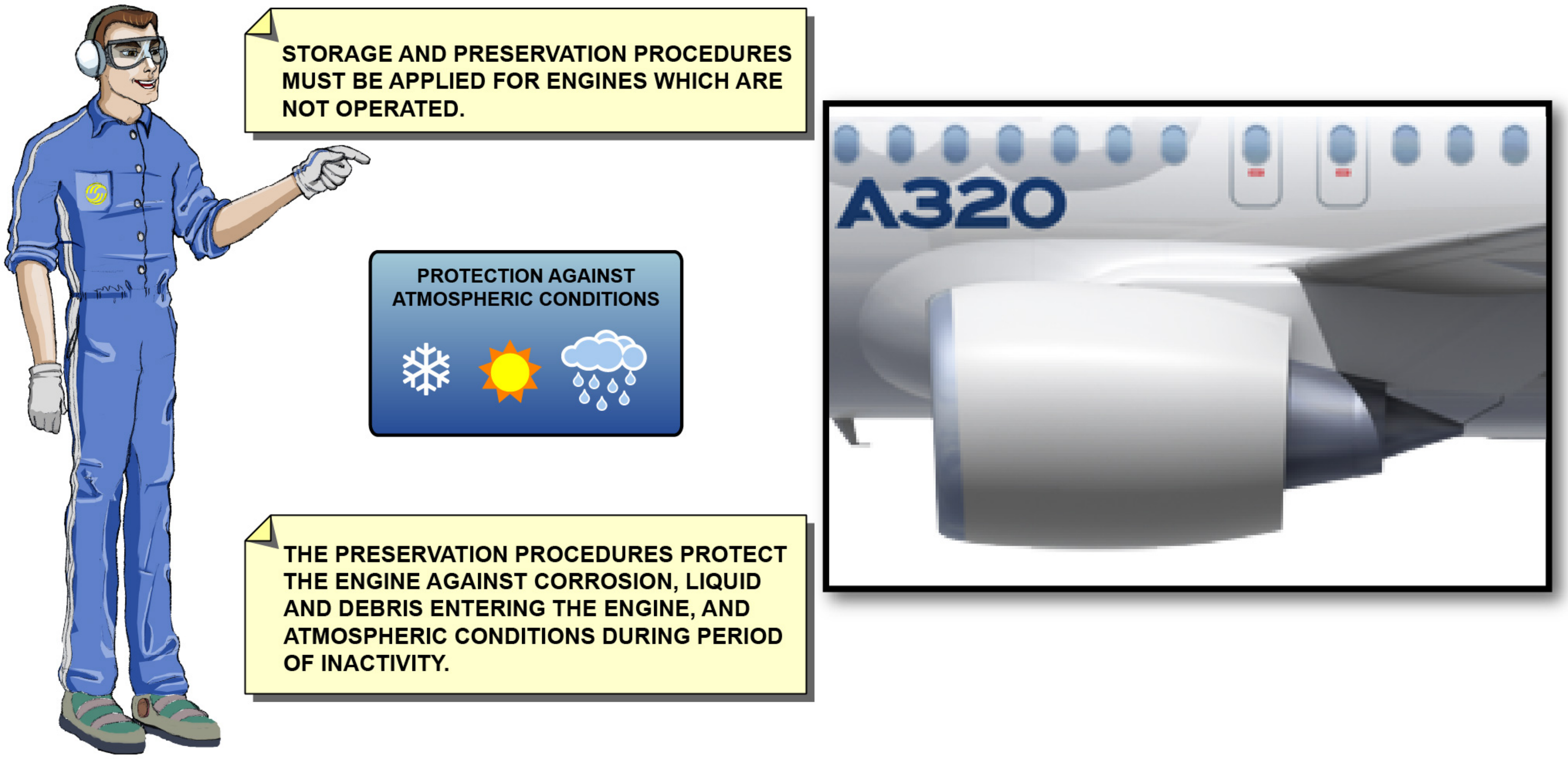


SAFETY PRECAUTIONS

70 POWER PLANT PW1100G PRESENTATION (1)

STORAGE AND PRESERVATION

Storage and preservation procedures must be applied to engines which are not operated. The preservation procedures protect the engine against corrosion, liquid and debris entering the engine, and atmospheric conditions during period of inactivity.



CAUTION

UNDER NO CIRCUMSTANCES SHALL PRESERVATIVE OIL OR EQUIVALENT BE SPRAYED INTO THE ENGINE INLET, CORE COMPRESSOR OR TURBINE, OR ENGINE EXHAUST. DIRT PARTICLES DEPOSITED ON THE WET BLADES AND VANES MAY ADVERSELY AFFECT ENGINE PERFORMANCE DURING SUBSEQUENT OPERATION.

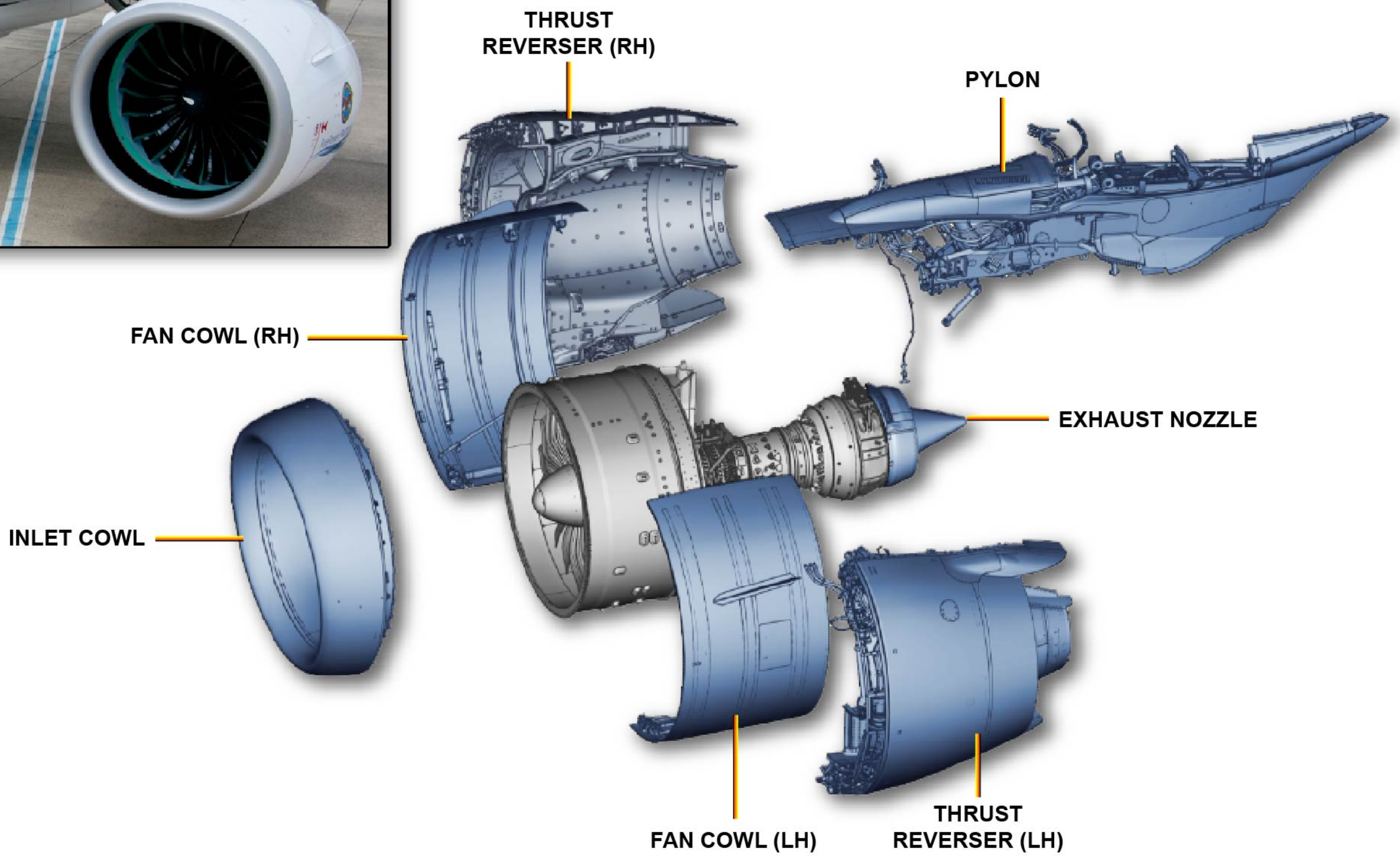
STORAGE AND PRESERVATION

UJ515241 - U08T0MEP - UM70PZPW1100G07

POWERPLANT SYSTEM COMPONENT LOCATION (2)

SYSTEM OVERVIEW

The PW1100G engine is an axial flow, dual-rotor, geared fan, variable stator, ultra high bypass ratio power plant.
The PW1100G engines power the A319, A320 and A321 aircraft of the A320 NEO family. PW1100G engines are available in several thrust ratings.
The geared turbo fan engine provides improved fuel efficiency and reduces engine noise. It also reduces the CO2 and NOx emissions.
All the engines are basically the same. The Data Storage Unit (DSU) on the Electronic Engine Control (EEC) provides the possibility of changing the thrust rating.
The power plant installation includes the engine, the engine inlet, the exhaust, the fan cowls and the reverser assemblies. The pylon connects the engine to the wing structure. The engine is attached to the pylon by FWD and AFT mounts.



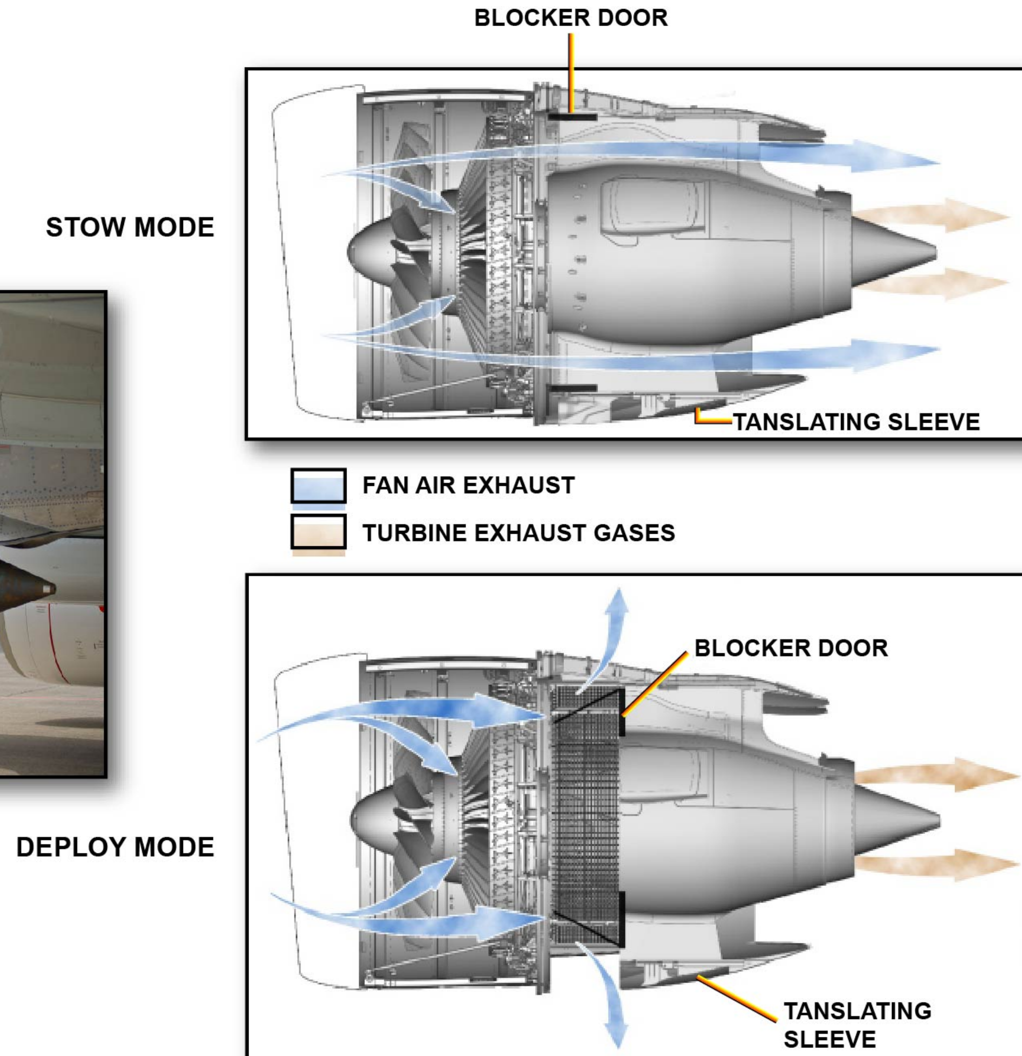
SYSTEM OVERVIEW

POWERPLANT SYSTEM COMPONENT LOCATION (2)

SYSTEM OVERVIEW (continued)

THRUST REVERSER SYSTEM

The thrust reverser system operated from the cockpit consists of 2 hydraulically operated translating sleeves.
When the translating sleeve moves aft during deployment, it lifts blocker doors that redirect the engine fan airflow.



SYSTEM OVERVIEW - THRUST REVERSER SYSTEM

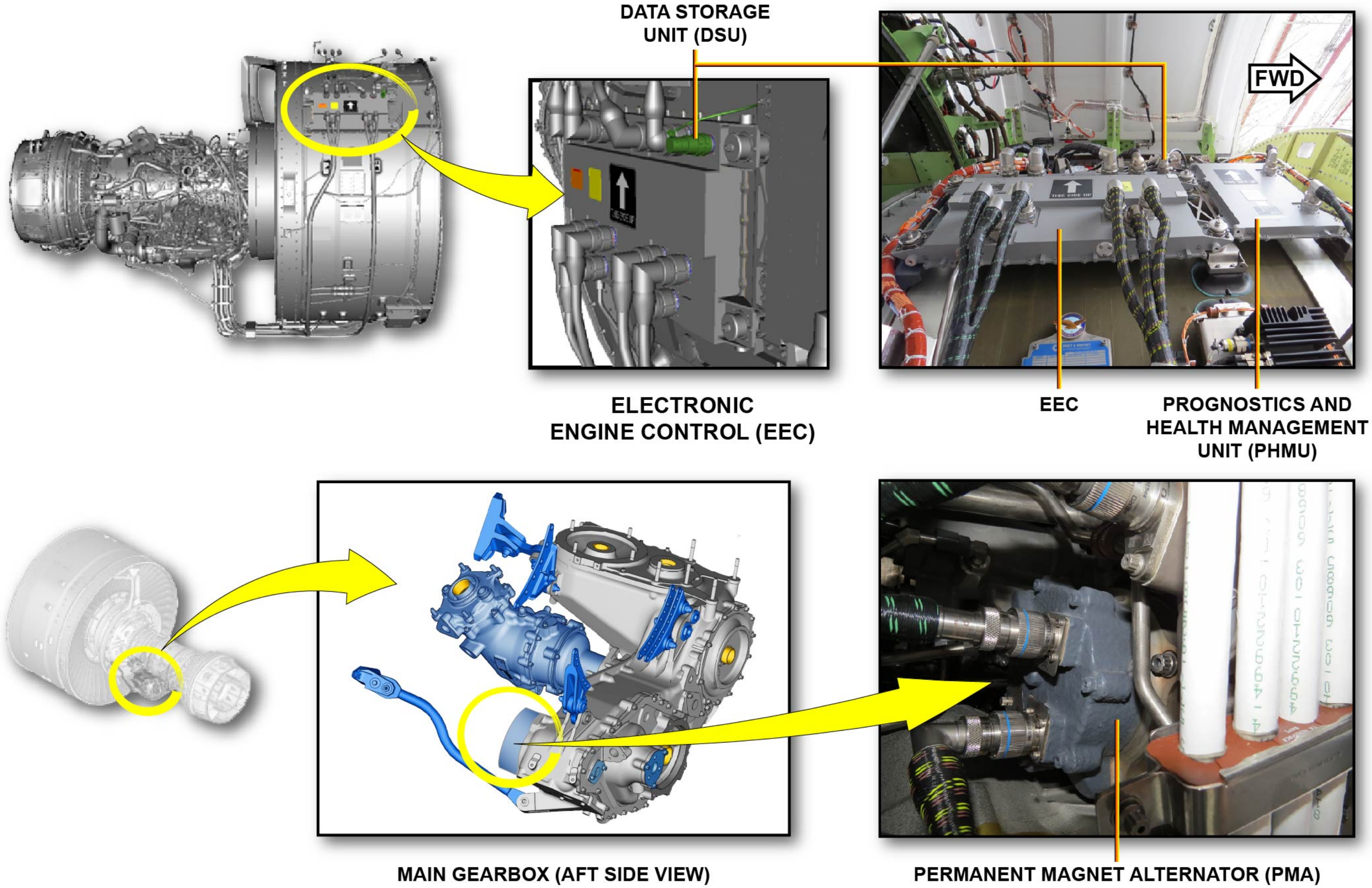
POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION

The engine system components are at the following locations.

FADEC

The EEC and Prognostics and Health Management Unit (PHMU) are on the RH side of the fan case.
The DSU is onto the top of the EEC on Channel A side and connected to the engine case bracket by a lanyard.
The FADEC Permanent Magnet Alternator (PMA) is on the forward face of the main gearbox.



COMPONENT LOCATION - FADEC

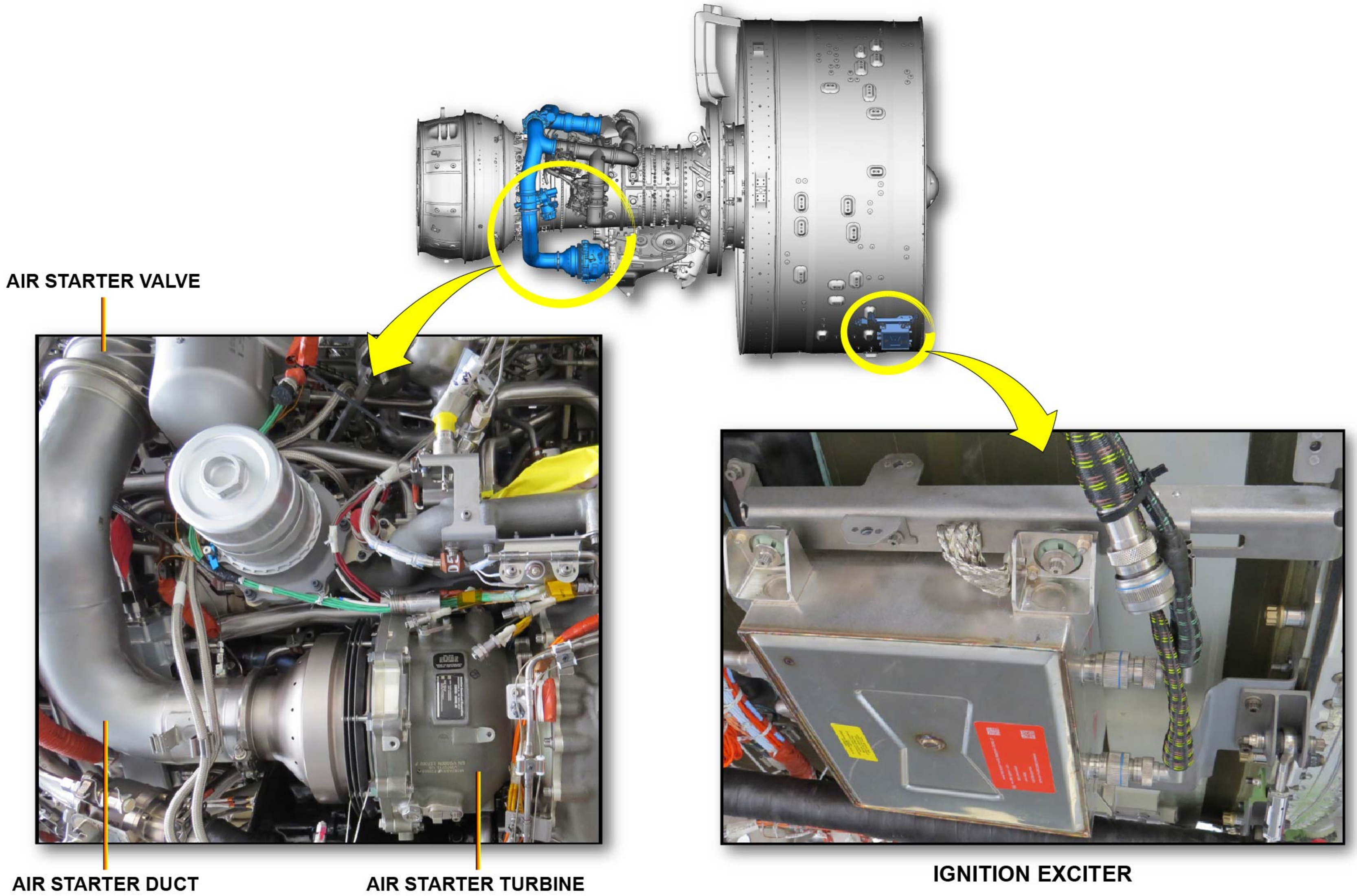
UJ515241 - U08T0MEP - UM70C1COMPLOC05

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

IGNITION & STARTING

One ignition exciter box is on the RH side of the engine fan case at 5 o'clock.
The air starter is at 3 o'clock aft of the main gearbox.



COMPONENT LOCATION - IGNITION & STARTING

UJ515241 - U08T0MEP - UM70C1COMPLOC05

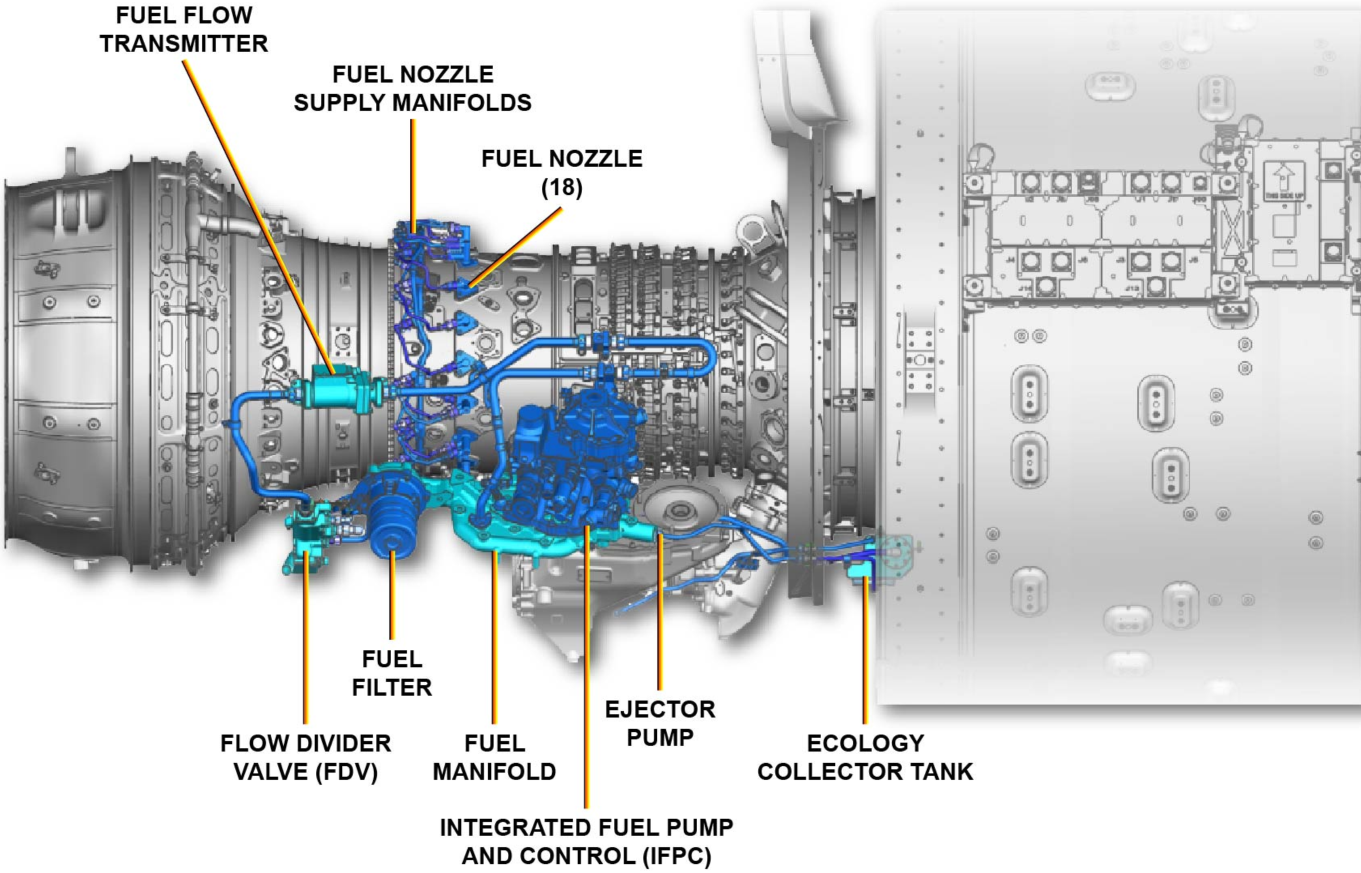
POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

FUEL

The primary components of the fuel system are on the RH side of the engine core.
The Integrated Fuel Pump and Control (IFPC) is attached with bolts to the fuel manifold on the right side of the main gearbox at the 3 o'clock position.

FUEL DISTRIBUTION SYSTEM (RIGHT SIDE)



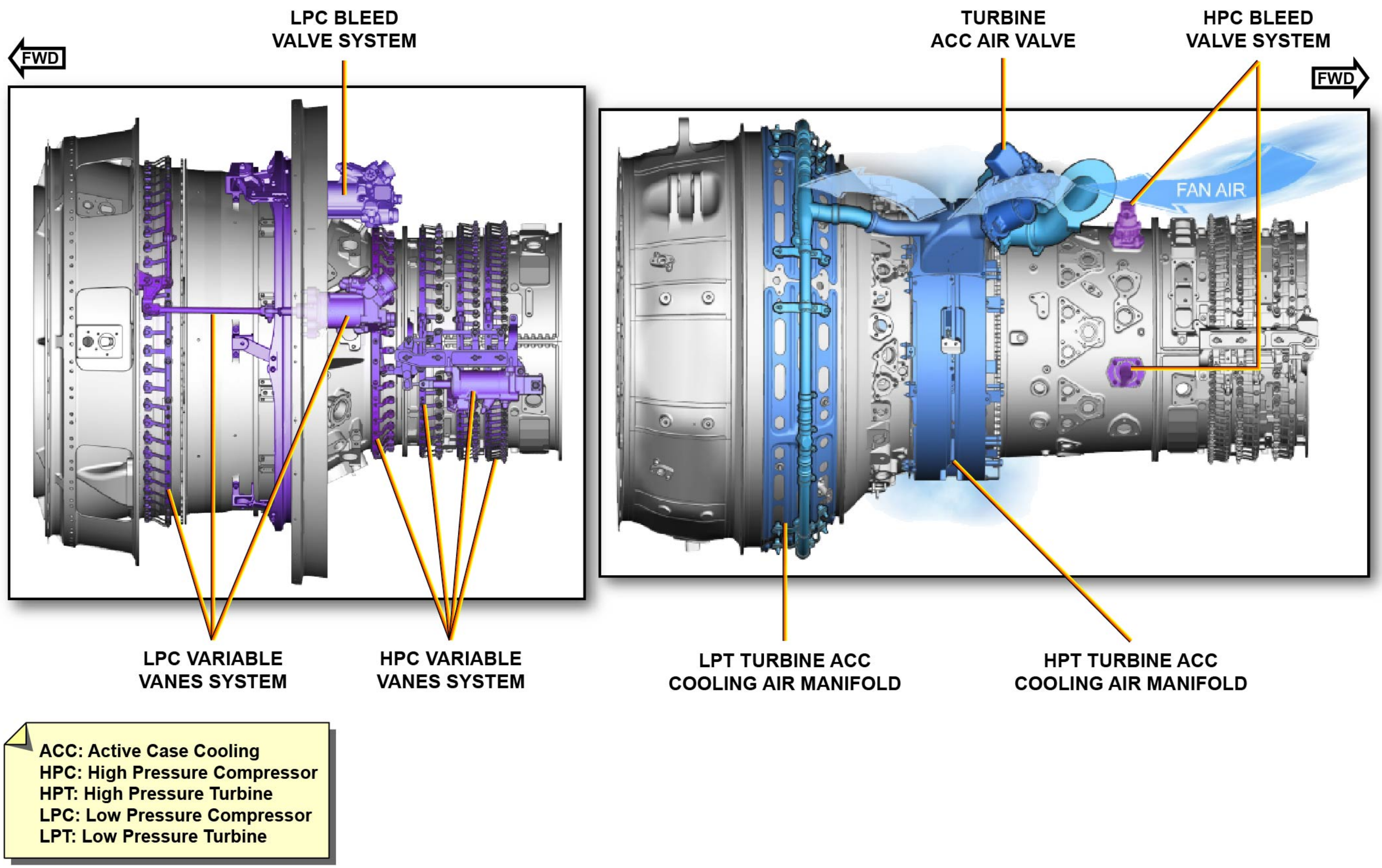
COMPONENT LOCATION - FUEL

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

AIR

The next picture shows the compressor airflow control and the turbine case cooling systems.



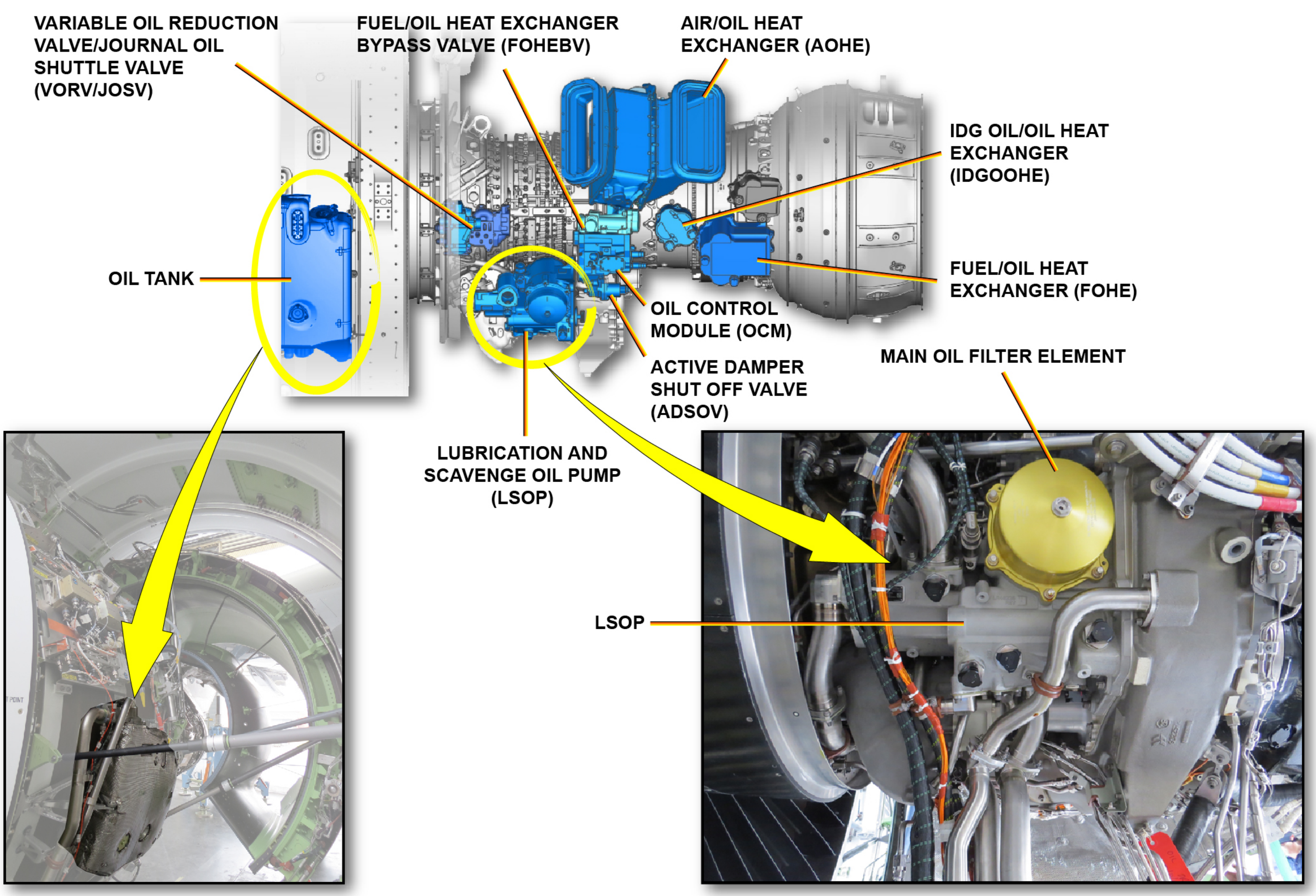
COMPONENT LOCATION - AIR

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

OIL

The engine oil tank is attached with frangible mounts to the fan case on the left hand side of the engine at the 9 o'clock position.
The Lubrication and Scavenge Oil Pump (LSOP) is attached to the rear of the main gearbox at the 6 o'clock position.



COMPONENT LOCATION - OIL

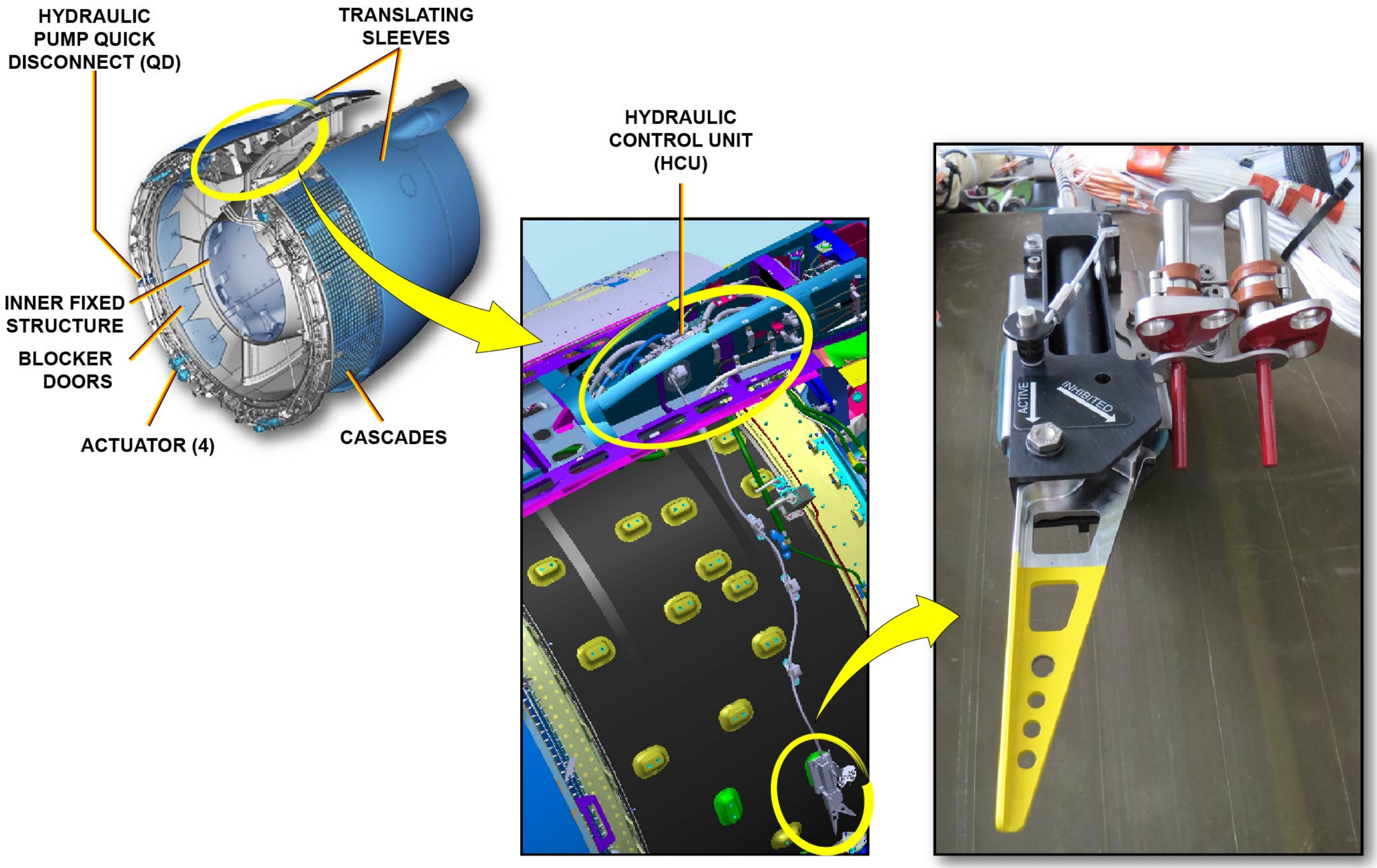
UJ515241 - U08T0MEP - UM70C1COMPLOC05

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

THRUST REVERSER

Two translating sleeves are hydraulically operated. The Hydraulic Control Unit (HCU) is installed on the pylon.
On the A320NEO PW1100G, the HCU is made of an Isolation Control Unit (ICU) and a Directional Control Unit (DCU) attached together.
Reverser inhibition is possible via a remote lever.



INHIBITION REMOTE LEVER

COMPONENT LOCATION - THRUST REVERSER

UJ515241 - U08T0MEP - UM70C1COMPLOC05

ENGINE SYSTEM CONTROL & INDICATING (2)

LOCATE CONTROL/INDICATING IN COCKPIT

FADEC POWERING / ENGINE CONTROLS

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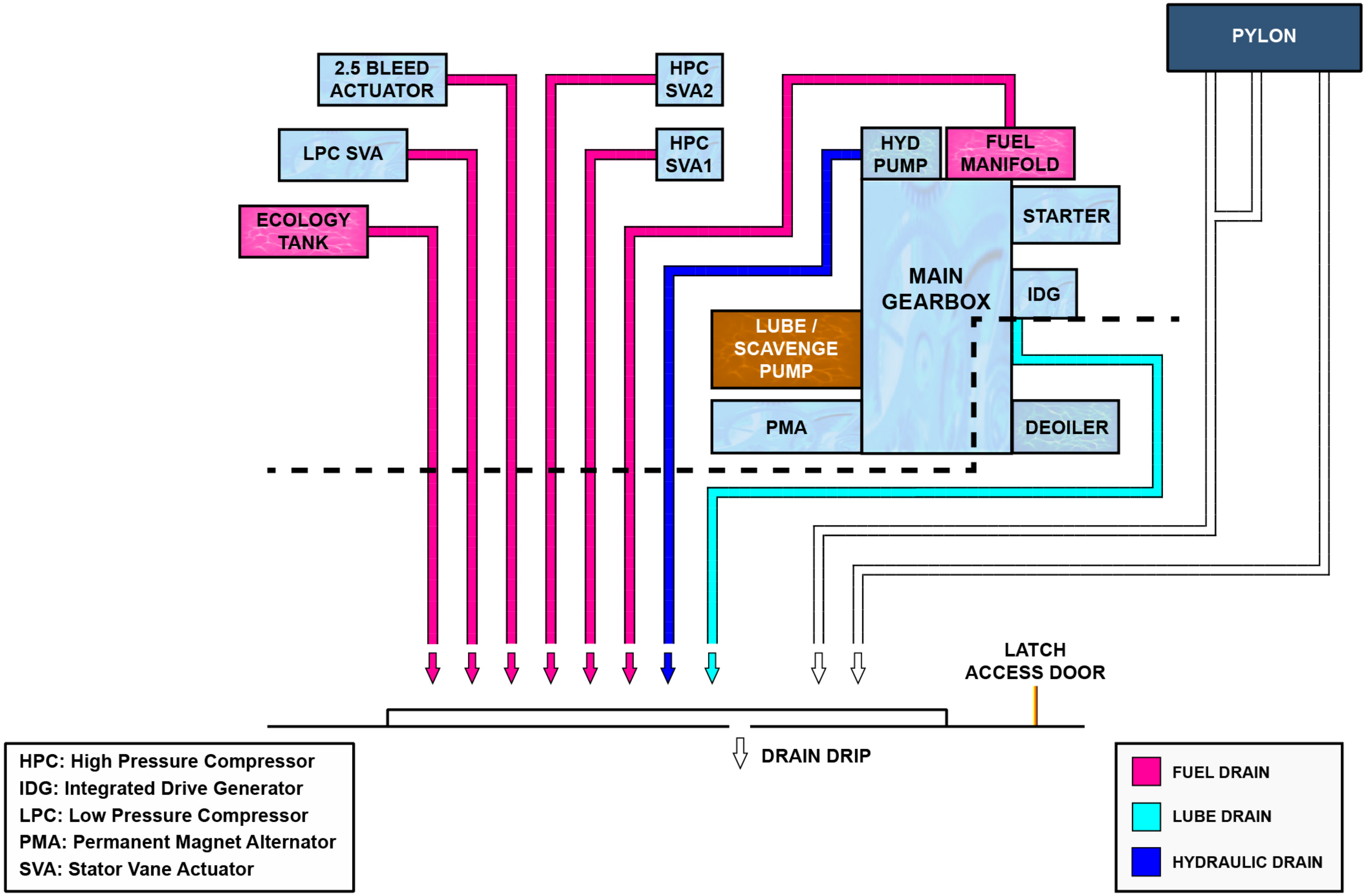
POWER PLANT DRAIN PRESENTATION (2)

PYLON & ENGINE DRAINS

The drains from the engine and pylon exit the nacelle through a drain mast.
The drains system provides a controlled leak path exit to the 6 o'clock position of the nacelle for hydraulic, oil and fuel systems.
The drains system is comprised of the upper pylon drains hoses, lower drains through the nacelle bifurcation and the scupper drains assembly attached to the fan case providing drainage for the oil reservoir.
At the lower bifurcation, lateral, core and aft support for the 10 drains tubes is provided through the mid-clamp support attached to the Nacelle Anti-Icing (NAI) flag and through the latch beam seal interface.



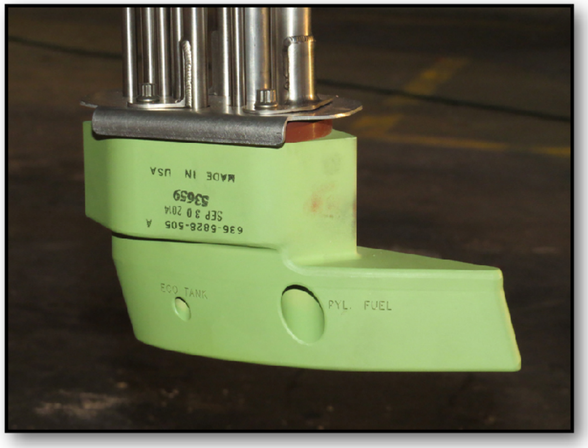
PYLON & ENGINE DRAINS

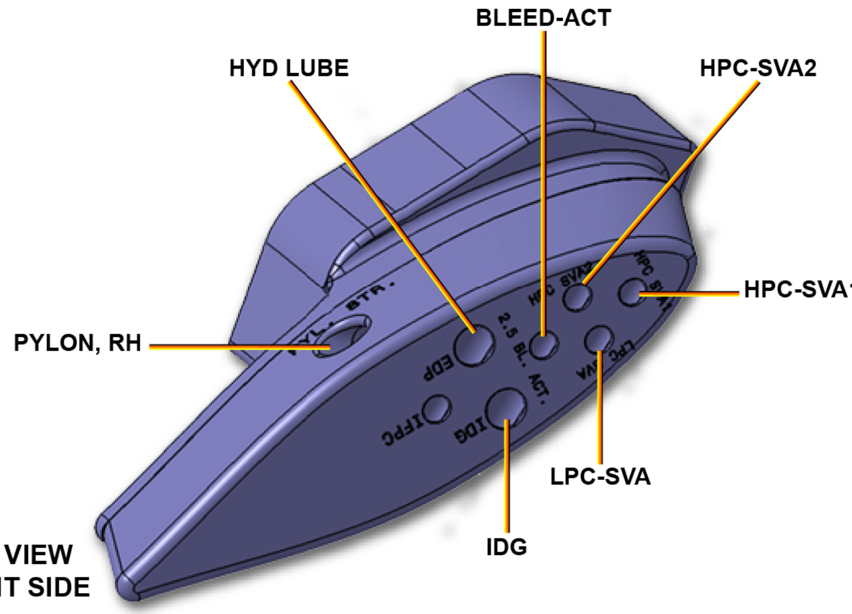
UJ515241 - U08T0MEP - UM71P1PW1100G05

POWER PLANT DRAIN PRESENTATION (2)

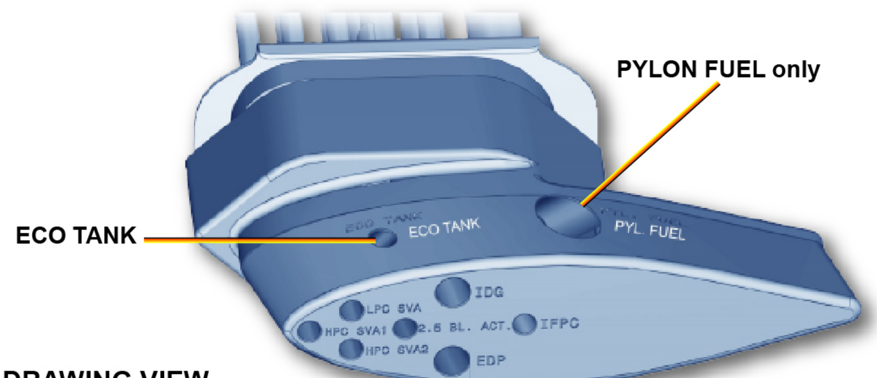
DRAIN MAST

At the 6 o'clock position an aerodynamic drain mast protrudes below the nacelle surface. The drain mast also has exit holes on the sides and bottom surface which are identified to enable trouble shooting of the leaking components.





DRAWING VIEW
FROM RIGHT SIDE



IFPC: Integrated Fuel Pump and Control

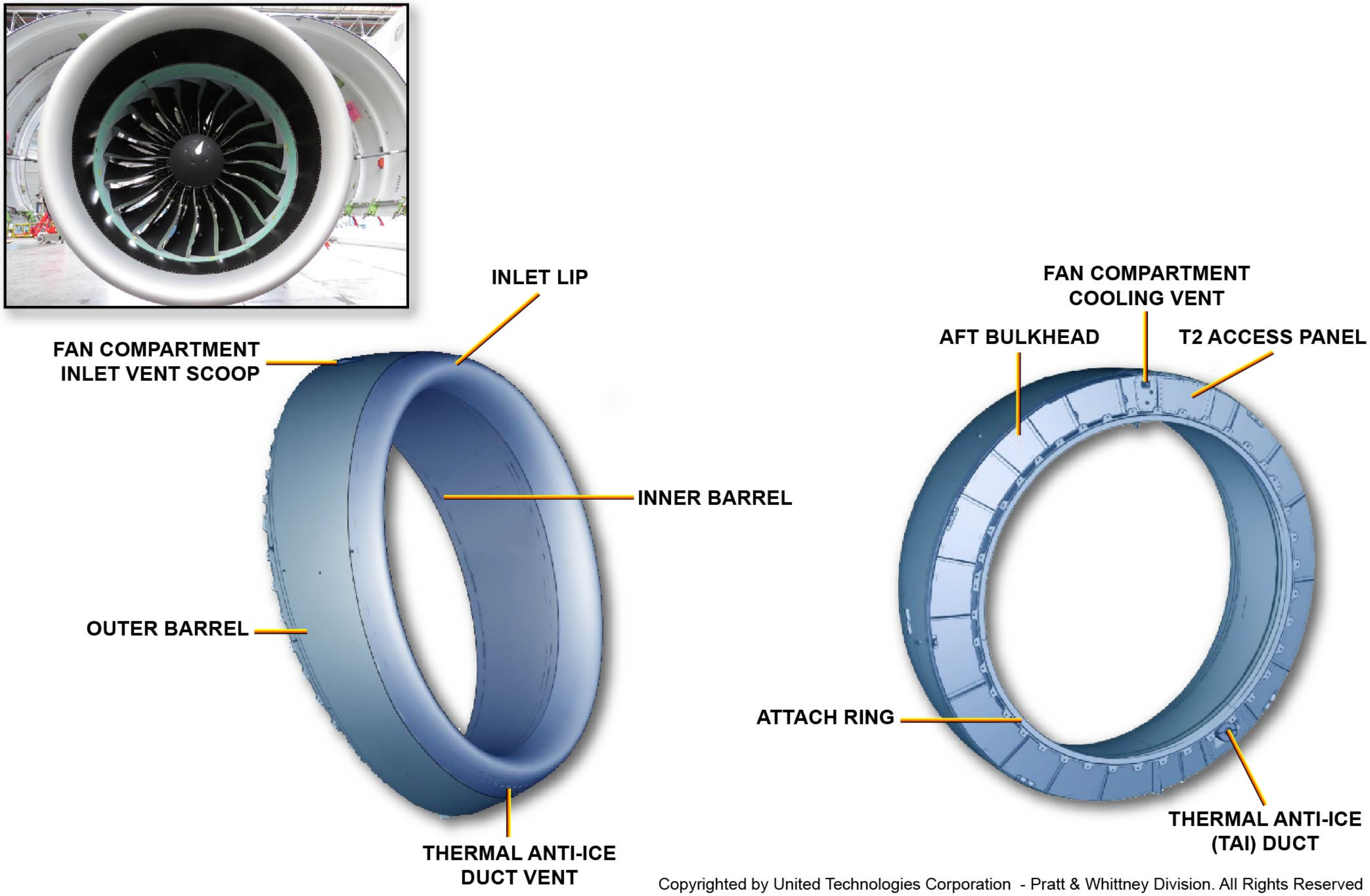
DRAWING VIEW
FROM LEFT SIDE

DRAIN MAST

POWER PLANT INSTALLATION D/O (3)

INLET COWL

The inlet cowl is composed of an inner barrel, outer barrel, forward bulkhead, aft bulkhead and a nose lip.
The inner barrel has acoustic liners for noise suppression. It also accommodates the T2 probe.
The outer barrel has a small flush inlet vent scoop located at 12 o' clock position to provide ram air for fan compartment cooling. It also has Nacelle Anti Ice Exhaust Ports at the 6 o' clock position.
The inner and outer barrels are made of composite material.
The forward and aft bulkhead provides support and rigidity to the structure.
The inlet lip is made of a single piece aluminium alloy for engine anti-ice purpose.
It includes installation of interphone jack for service interphone.
For removal and installation, the inlet cowl is attached to the engine at the attach ring with 40 bolts.


INLET LIP
FAN COMPARTMENT INLET VENT SCOOP
INNER BARREL
OUTER BARREL
THERMAL ANTI-ICE DUCT VENT
FAN COMPARTMENT COOLING VENT
AFT BULKHEAD
T2 ACCESS PANEL
ATTACH RING
THERMAL ANTI-ICE (TAI) DUCT
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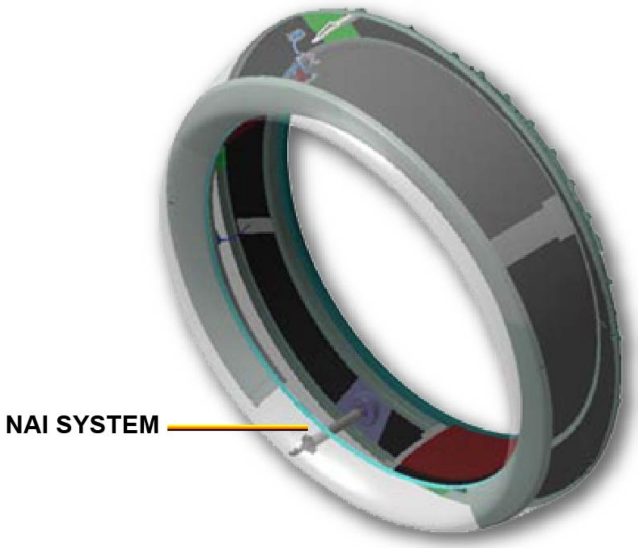
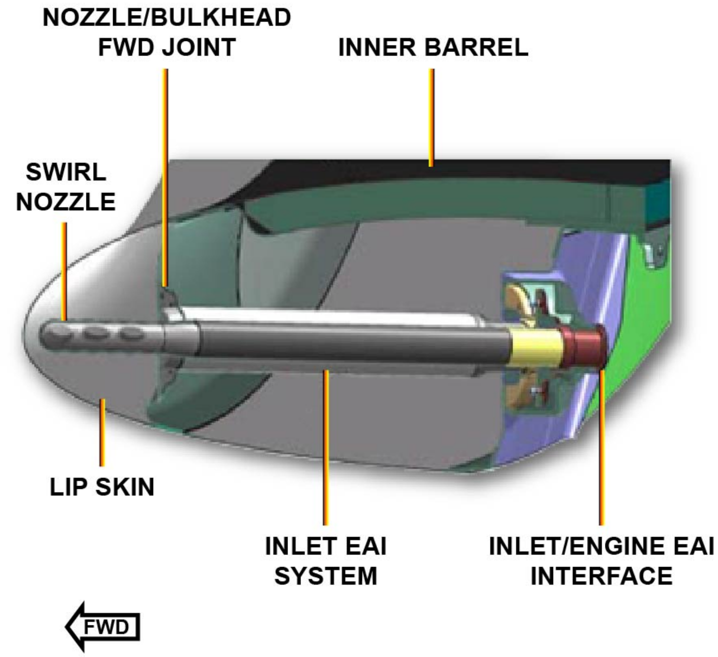
INLET COWL

POWER PLANT INSTALLATION D/O (3)

AIR INTAKE FUNCTIONS

The main function of the inlet cowl is to guide the airflow into the engine inlet and to permit an aerodynamic airflow over the outer surface of the engine.
When the engine anti icing is selected to ON from the cockpit overhead panel, hot bleed air from the engine is ducted to the cowl nose lip to prevent ice build-up. The hot air enters to the inlet lip through a dedicated duct at the 4 o' clock position in the outer bulkhead. The air then exhausts overboard through a flush exit ports at the 6 o' clock position in the outer barrel.
The outer barrel has an impregnated copper screen layer for protection against lightning strike.



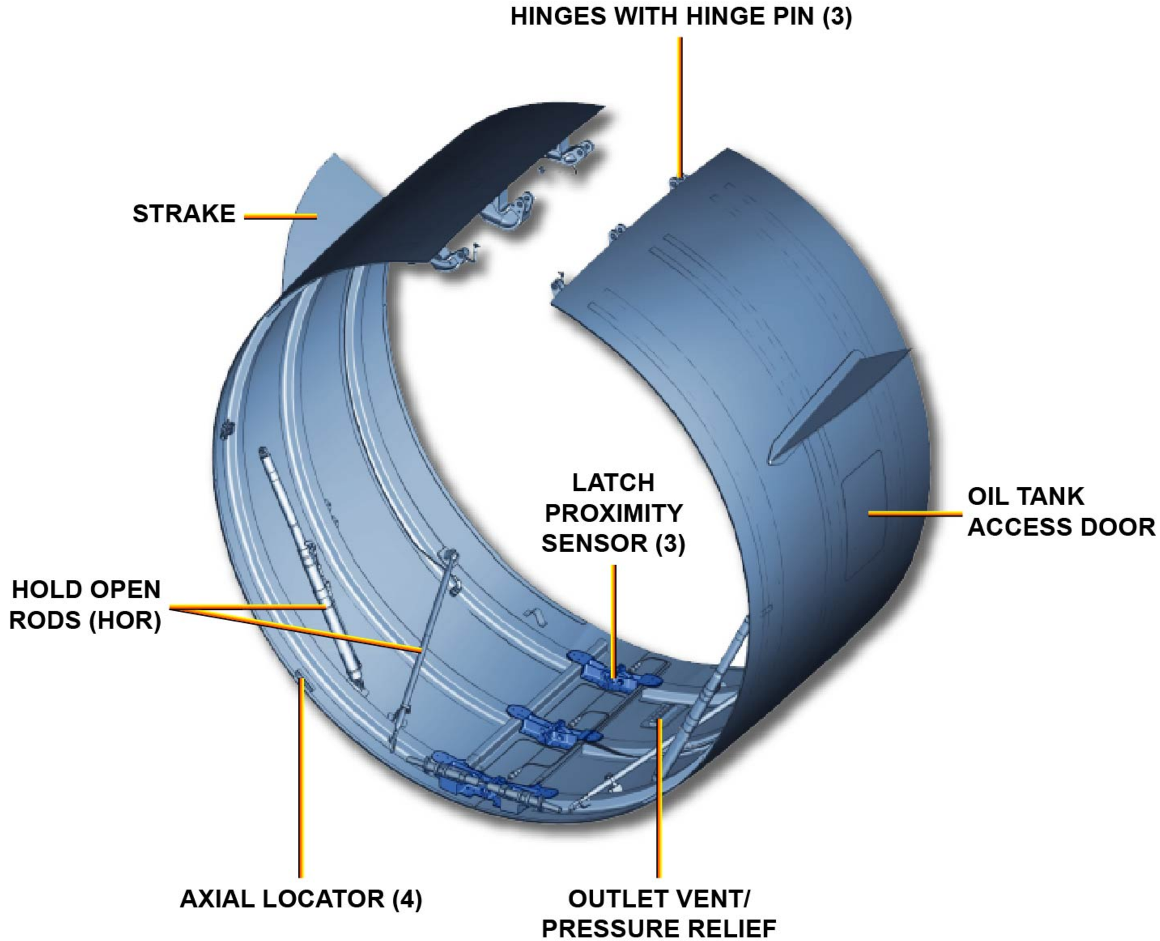


AIR INTAKE FUNCTIONS

POWER PLANT INSTALLATION D/O (3)

FAN COWL DOORS

There are two fan cowl doors to enclose the fan case and provide aerodynamic smoothness around the engine.
They are attached to the pylon by three hinges with hinge pins.
The door assembly is latched along the bottom centerline by three latches. These latches have a mounting mechanism and visual indicators to ensure that they are properly secured.
Proximity sensors are installed on each latch which sends its position signal to the Engine Interface Unit (EIU) for generating necessary warning.
The door can be opened manually. Each door is provided with 2 telescopic hold open rods, for opening.
The fan cowl door rests on 4 axial locators, when closed.
It also has hoist points, for removal and installation.
Aerodynamic strakes are mounted on the fan cowls to improve aircraft performance during manoeuvres.
Access doors on the LH side fan cowl door facilitates engine oil servicing and the Thrust reverser Hydraulic Control Unit (HCU) de-activation without opening the fan cowl.
A vent grill near the 6 o' clock position permits the air to escape out in case of damage of the anti-ice duct. The same is used for draining any fluids in and around the fan case.



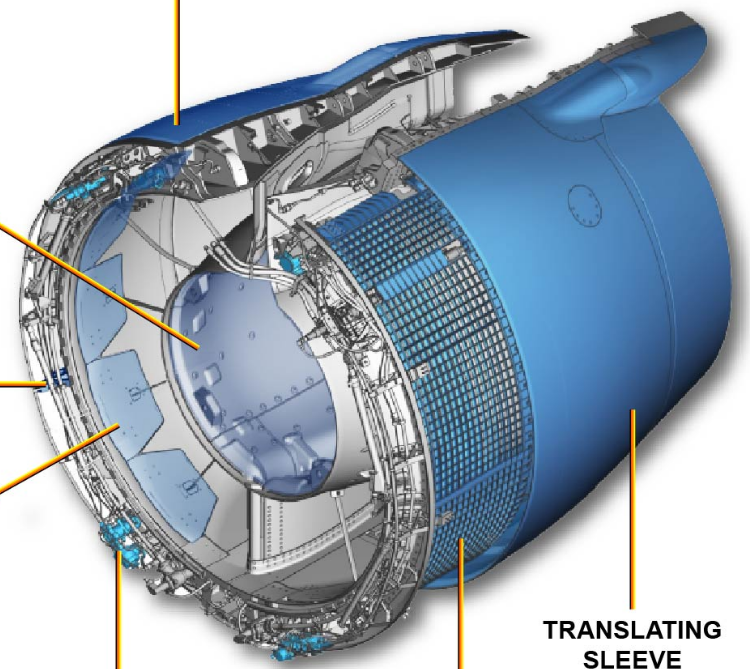
FAN COWL DOORS

UJ515241 - U08T0MEP - UM71D1PW1100G05

POWER PLANT INSTALLATION D/O (3)

THRUST REVERSER COWL DOORS

The thrust reverser cowl doors (or "C" Ducts) are in two halves. Each half includes one translating sleeves, two actuators, five blockers doors and cascades.
The thrust reverser cowls provide a smooth air flow around the engine area and enclose the engine core components, gear boxes and pipelines.
Each half is supported by 3 hinges at the pylon. The assembly is latched along the bottom centerline by seven latches.
Each half is provided with:
- Hoist points to install a handling sling for removal and installation,
- 1 opening actuator operated externally using a hydraulic hand pump for opening the thrust reverser cowl for maintenance
- 1 hold open rod mounted on the fan case for opening.

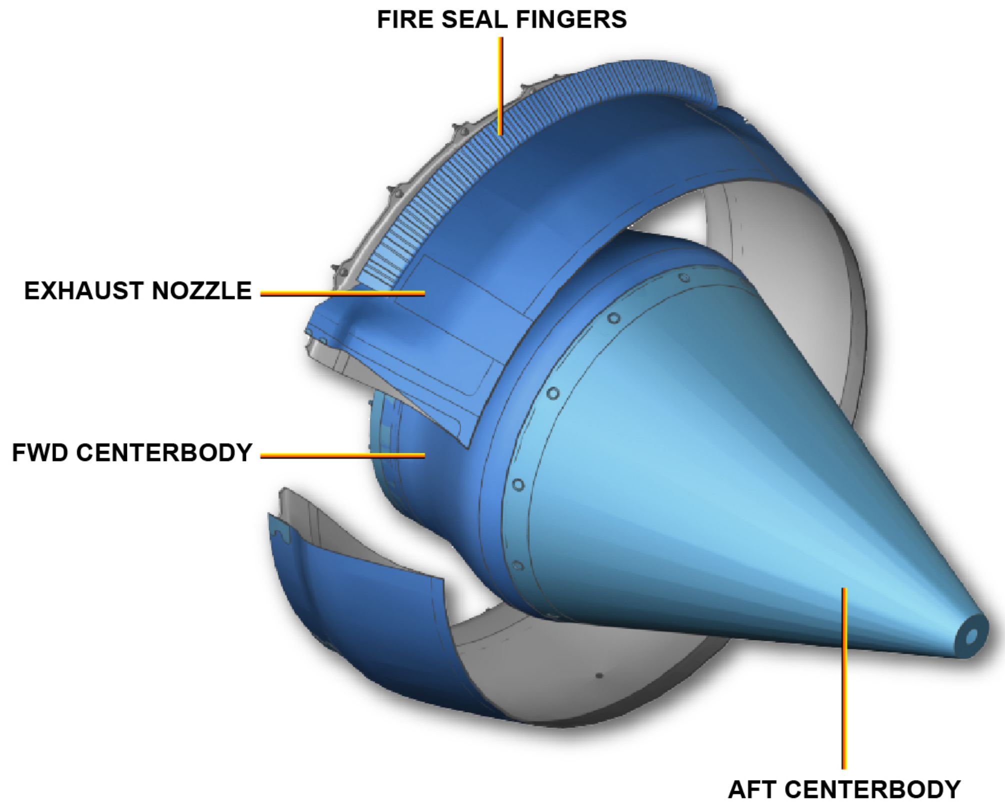


THRUST REVERSER COWL DOORS

POWER PLANT INSTALLATION D/O (3)

EXHAUST NOZZLE

The exhaust nozzle is formed by the center bodies and nozzle assembly. The annular passage between the exhaust nozzles and the centerbodies provide a smooth exit of the exhaust gas flow.
The fire seal fingers (turkey feathers) at the top of the exhaust nozzle prevents any flame from entering the core compartment area in the event of fire.
The centerbody also accommodates the drain outlet to expel hazardous fluids and vapors. These drains are located at the 6 o' clock position on the forward and aft center bodies.

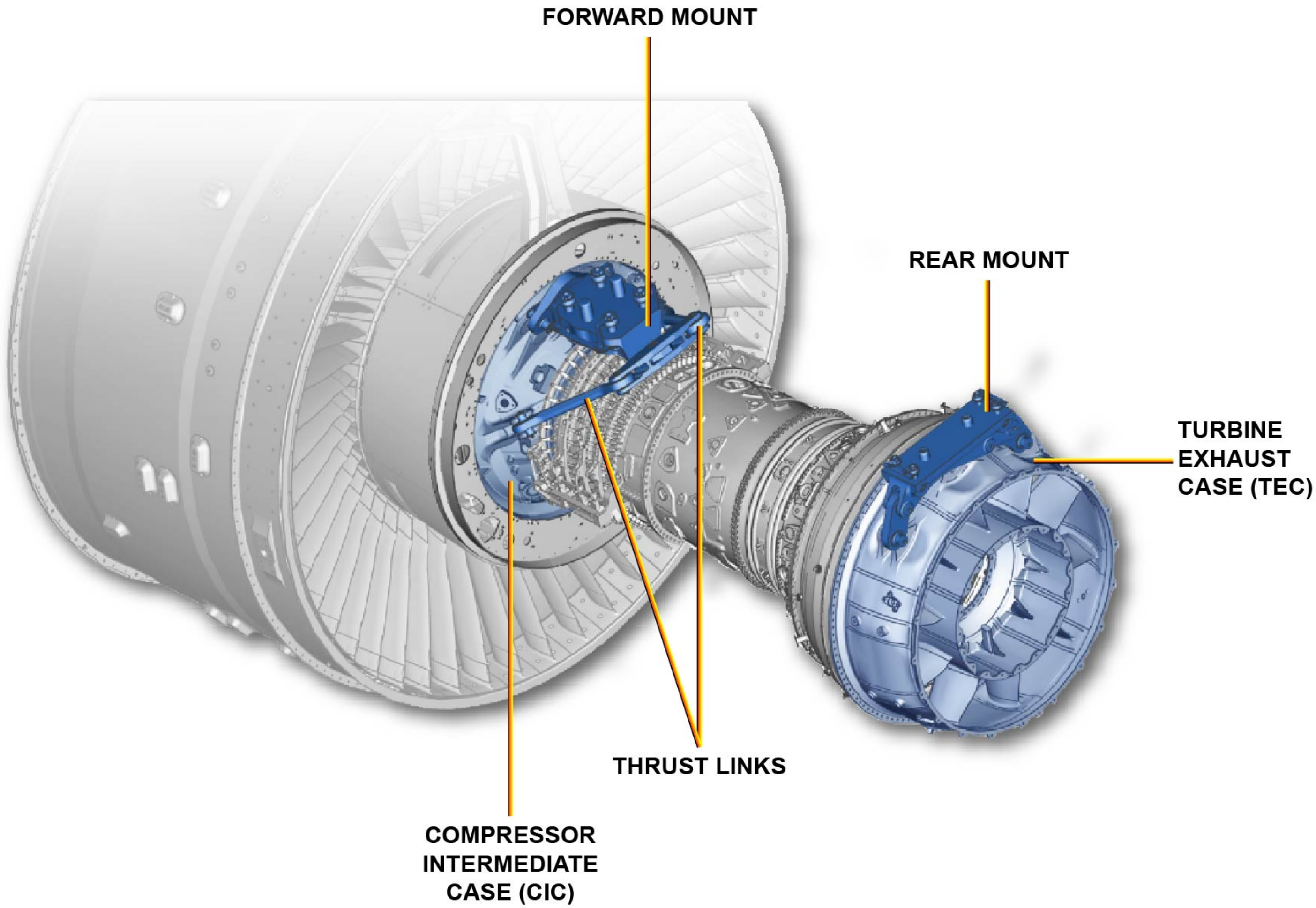


EXHAUST NOZZLE

POWER PLANT INSTALLATION D/O (3)

ENGINE MOUNTS

The engine is mounted to the pylon by the forward and aft mounts. They transfer the engine and thrust loads.
The forward mount assembly bears the engine thrust, vertical and lateral loads. The forward mount is attached to the engine at the Compressor Intermediate Case at 12 o' clock position. The forward mount is attached to the pylon by the help of four attachment bolts.
The thrust link assemblies attached to the forward mount take the lateral loads. They are attached to the forward mount through a balance beam. They are attached to the Compressor Intermediate Case at 09:30 and 02:30 position.
The aft mount assembly bears the engine vertical and radial loads. It is attached to the engine at the Turbine Exhaust Case (TEC) at 12 o' clock position. It is attached to the pylon by four bolts.



ENGINE MOUNTS

ENGINE SYSTEM D/O (3) (3)

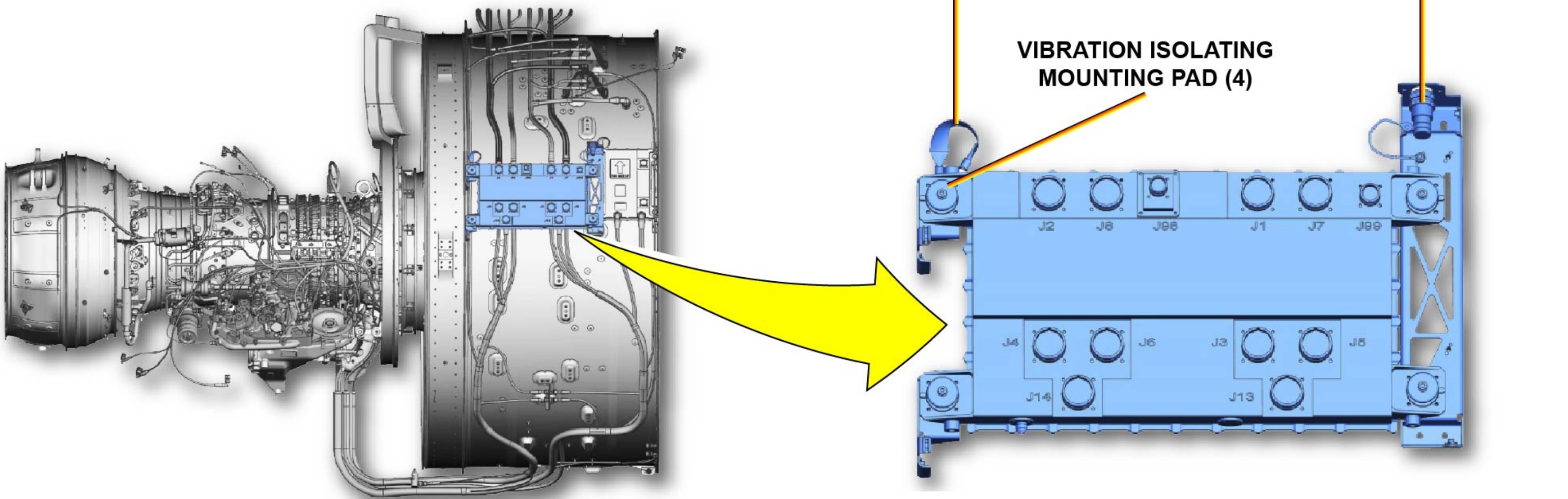
ENGINE CHARACTERISTICS

The Airbus A319, A320 and A321 aircrafts are powered by two PW1100G-JM turbofan engines.
This engine can produce a thrust from 22000 lbs (10000 kg) to 33000 lbs (14900 kg) depending on the aircraft version set by the Data Storage Unit (DSU) which is connected to the Electronic Engine Control (EEC).
The PW1100G-JM is a twin spool Ultra high bypass turbofan engine with the Fan Drive Gear System (FDGS) which enables the fan and the Booster Compressor to rotate at different speed thus improving engine efficiency.
The bypass ratio of this engine is 12:1.

ENGINE CONTROL

The engine includes a Full Authority Digital Engine Control (FADEC) system consisting of the EEC with two independent channels, sensors, actuators and other peripheral components on the engine. The FADEC system provides engine control, engine monitoring and help for maintenance and trouble shooting.

A/C	A/C model	ENG model	TakeOff Thrust
A319	A319-171	PW1121G-JM	21.5 Klbs
A319	A319-172	PW1122G-JM	22.9 Klbs
A319	A319-173	PW1127G-JM	26.8 Klbs
A320	A320-271	PW1127G-JM	26.8 Klbs
A320	A320-272	PW1124G-JM	24 Klbs
A321	A321-271	PW1133G-JM	32.7 Klbs
A321	1321-272	PW1130G-JM	29.7 Klbs

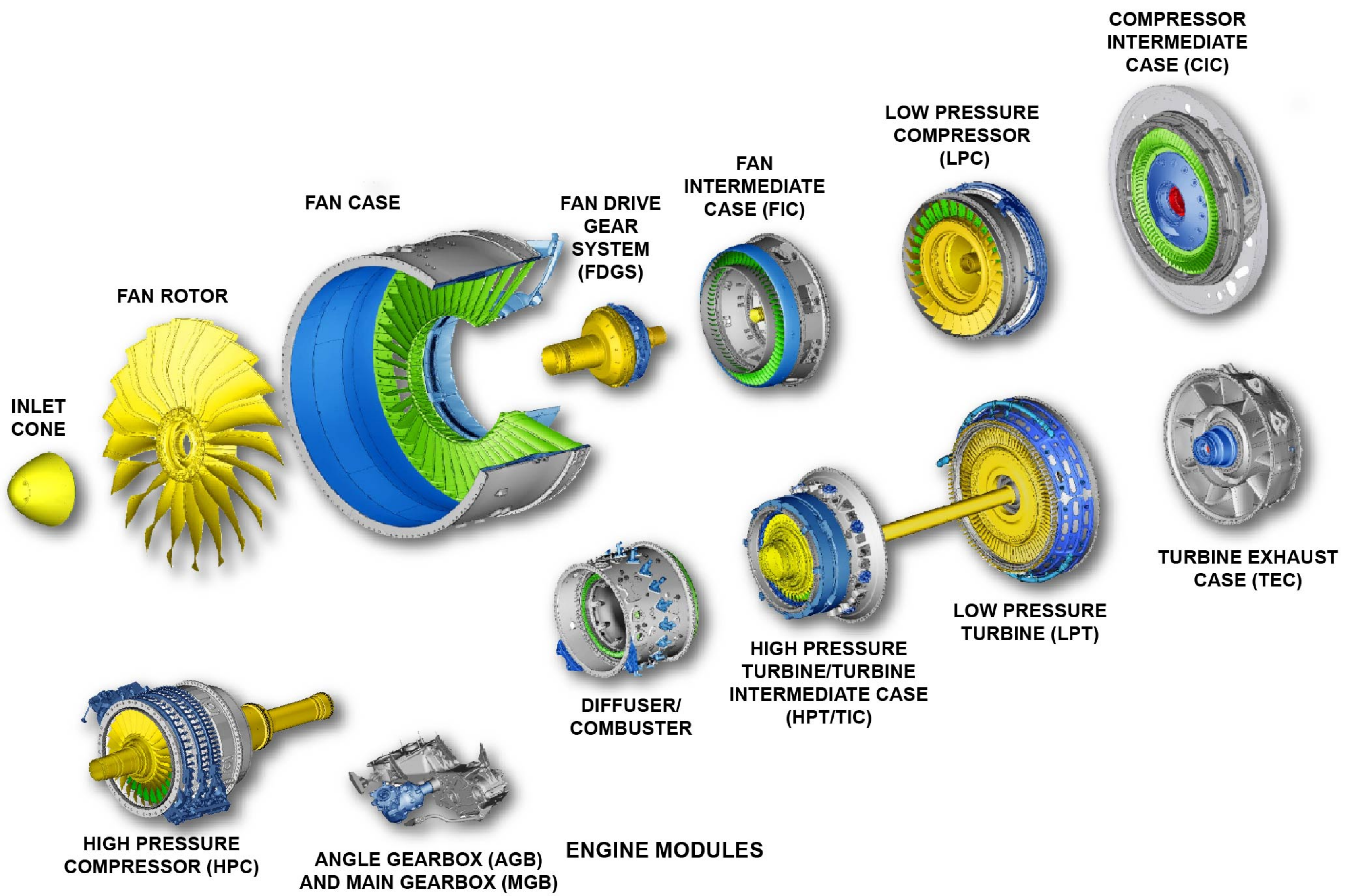


ENGINE CHARACTERISTICS - ENGINE CONTROL

ENGINE SYSTEM D/O (3) (3)

ENGINE MODULES

The engine rotor comprises of a single stage fan rotor, 3 stage LP Compressor, 8 stage HP Compressor, 2 stage HP turbine and 3 stage LP turbine. The engine is built on a modular concept.
The different modules are:
- Fan rotor,
- Fan case,
- FDGS,
- Fan Intermediate Case (FIC),
- Low Pressure Compressor (LPC),
- Compressor Intermediate Case (CIC),
- High Pressure Compressor (HPC),
- Diffuser and combustor,
- High Pressure Turbine (HPT),
- Turbine Intermediate Case (TIC),
- Low Pressure Turbine (LPT),
- Turbine Exhaust Case (TEC),
- Angle and Main Gear boxes.



ENGINE MODULES

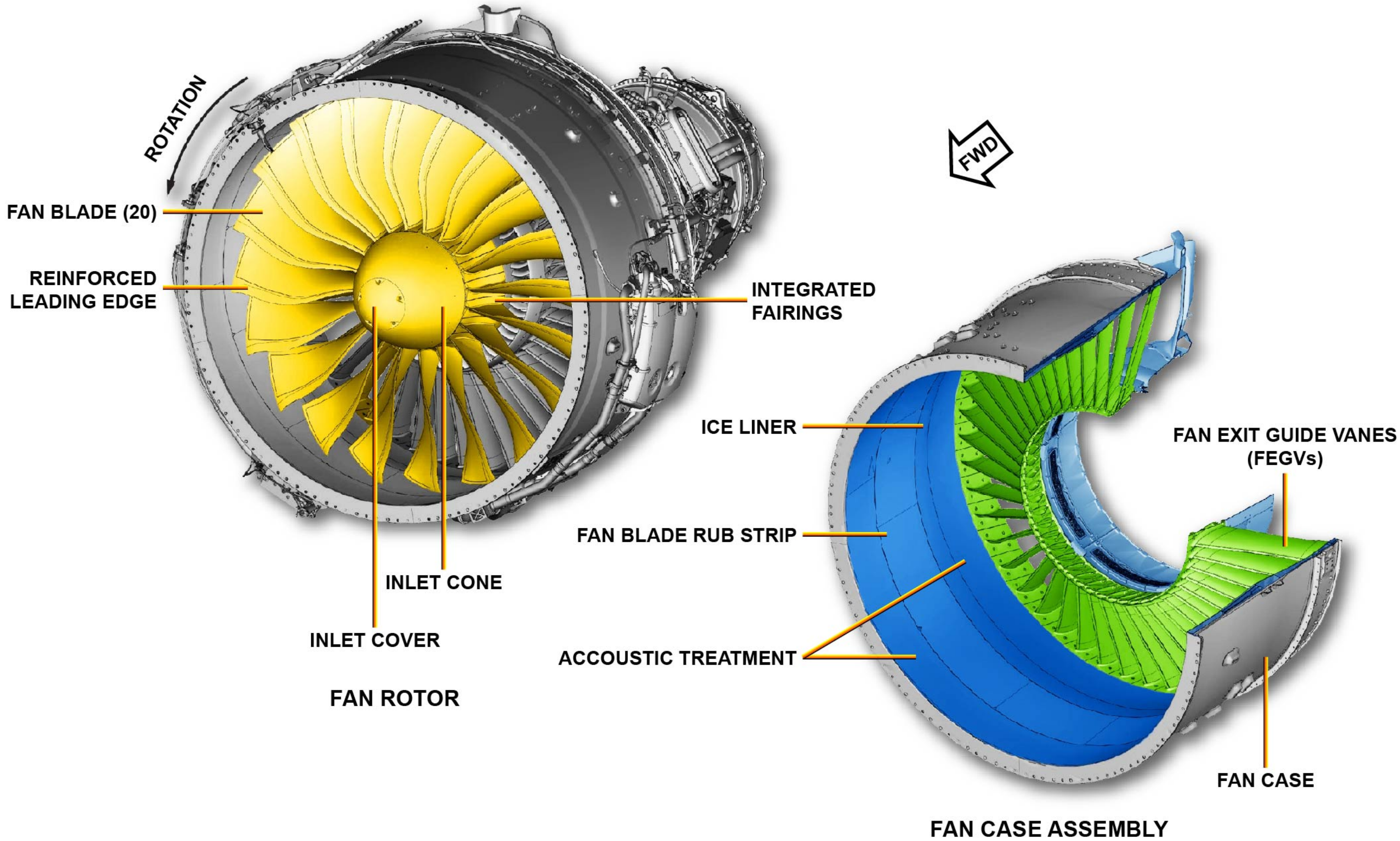
UJ515241 - U08T0MEP - UM72D1PW1100G05

ENGINE SYSTEM D/O (3) (3)

ENGINE MODULES (continued)

FAN ROTOR AND FAN CASE

The Fan rotor contributes to approximately 90% of the thrust.
The fan rotor comprises of the fan drive shaft, inlet cone and 20 wide chord fan blades. The fan blades are made of aluminium alloy honeycomb structure and reinforced by Titanium leading edges.
The fan rotational speeds being lower helps in reducing rotational loads and bird strike fan damage.
The fan rotates in a clockwise direction as viewed from the aft looking forward.
The inlet cone is made of composite material and is anti-iced with a continuous airflow from of the 2.5 compressor stage.
The fan case provides an annular path for the bypass air flow.
The case is made of single piece composite material (Kevlar). It holds the outer edge of the Fan Exit Guide Vanes (FEGV).
The inner walls behind the fan blade area are provided with acoustic liners for noise reduction.
A rubberized strip along the fan blade area helps in minimizing the gap and prevents contact between the blades and the case.



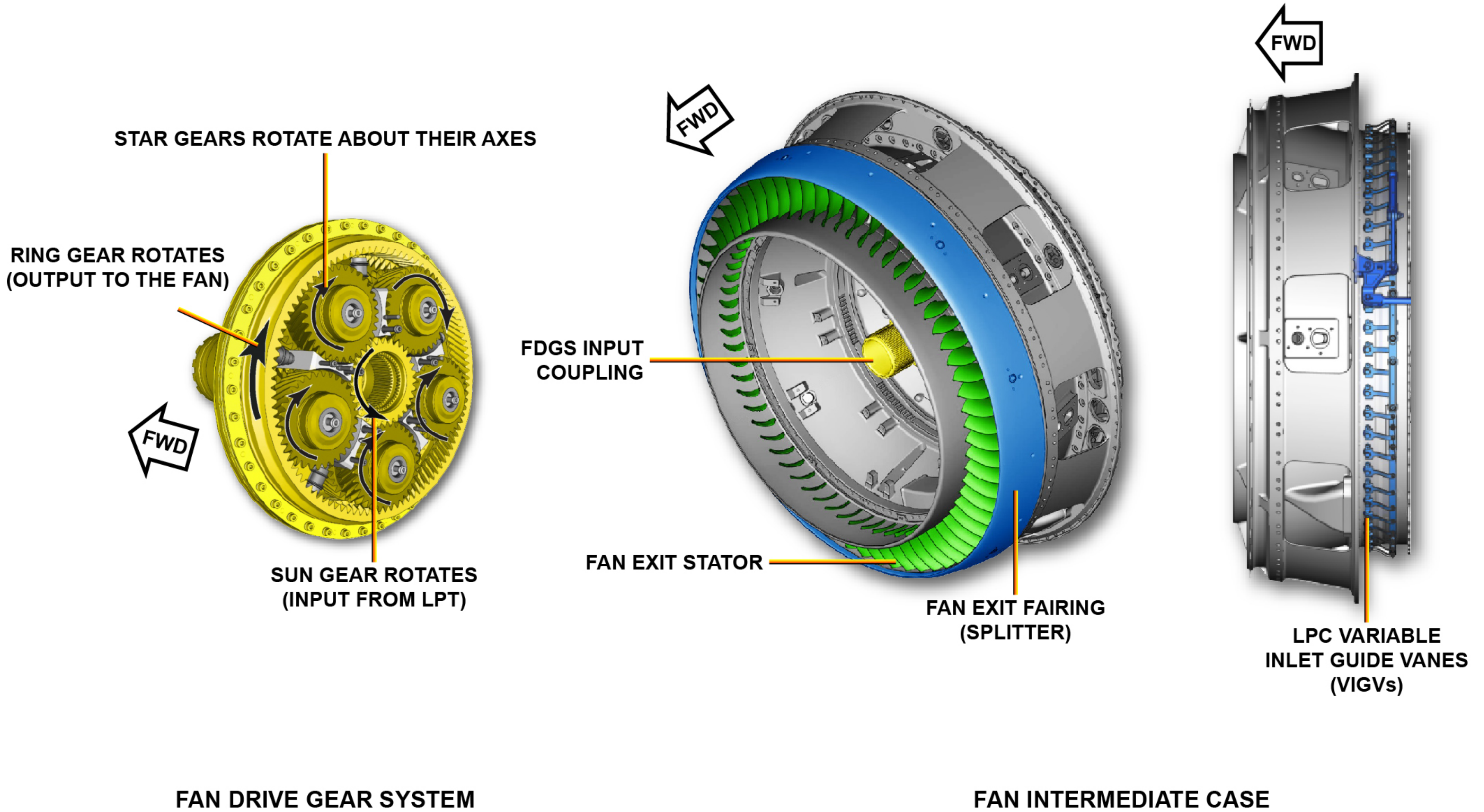
ENGINE MODULES - FAN ROTOR AND FAN CASE

ENGINE SYSTEM D/O (3) (3)

ENGINE MODULES (continued)

FAN DRIVE GEAR SYSTEM (FDGS) AND FAN INTERMEDIATE CASE

The FDGS allows the fan to be driven by the LP shaft at a lower speed.
The FDGS is a reduction gear mechanism which comprises of a central sun gear and five planetary gears arranged like a star.
It helps in reducing the fan rotating speed and permits the LPC to rotate at a higher speed. This helps in improving engine performance and efficiency.
The ratio of the LPC speed: fan speed is approximately 3:1.
The LPC rotates in the opposite direction of the fan rotor.
The FIC supports the FDGS and the bearings No. 1, 1.5 and 2.
It also supports the inner edge of the Fan Exit Guide Vanes (FEGVs) and the support fairings.
It houses a single stage Variable Inlet Guide Vanes (VIGVs) which direct the air to the LP Compressor at the correct angle.
The VIGV's are controlled by the EEC.



ENGINE MODULES - FAN DRIVE GEAR SYSTEM (FDGS) AND FAN INTERMEDIATE CASE

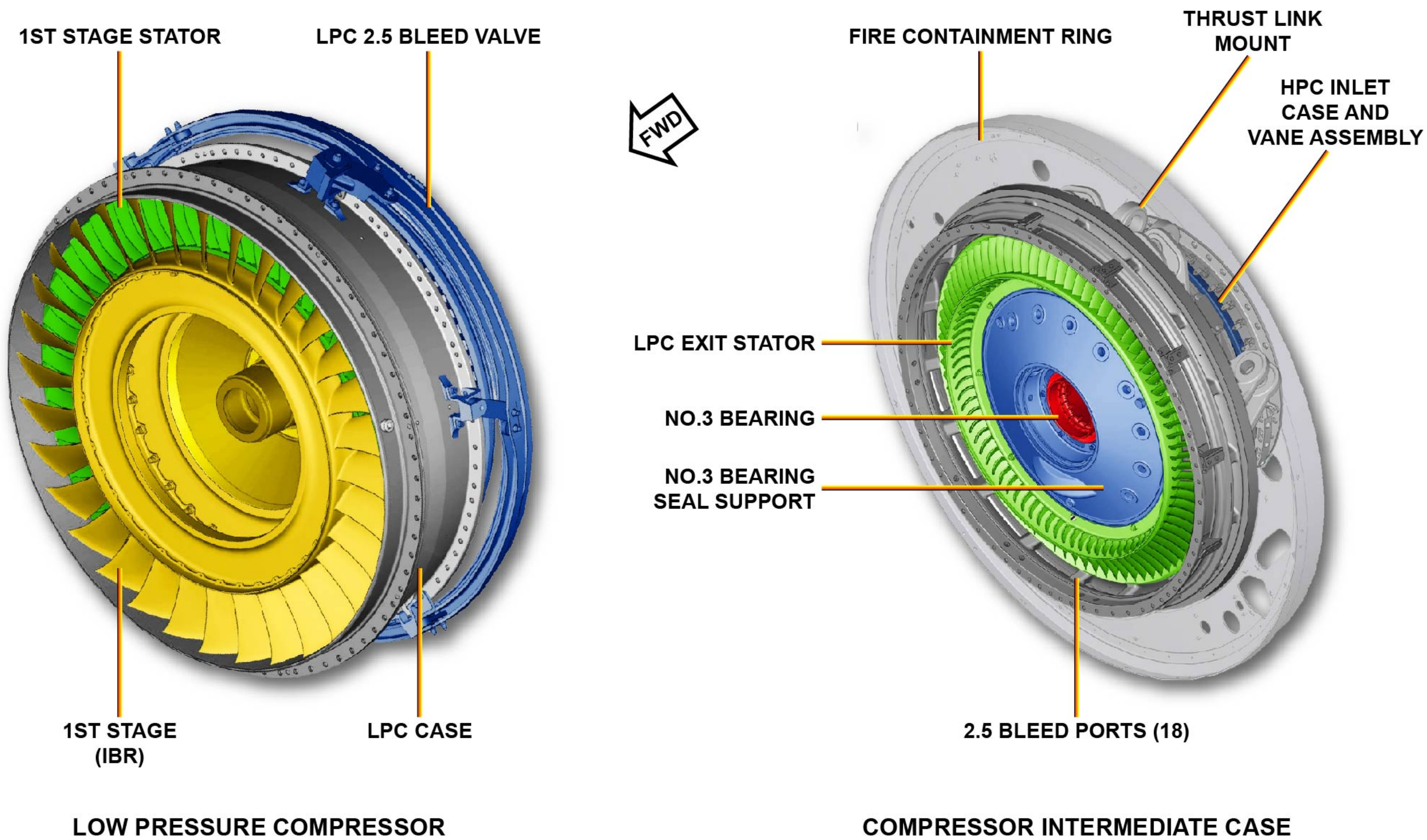
UJ515241 - U08T0MEP - UM72D1PW1100G05

ENGINE SYSTEM D/O (3) (3)

ENGINE MODULES (continued)

LOW PRESSURE COMPRESSOR AND COMPRESSOR INTERMEDIATE CASE

The LPC comprises of 3 stages of axial flow compressor with integrally bladed rotor, stators and the case.
It is connected to the FDGS to the front and the LP turbine shaft splines at the rear.
It rotates counter clockwise viewed from the rear.
It acts as a super charger to pressurize the air before it enters into the HPC.
It houses the 2.5 stage bleed valve at the rear which releases the air during engine operation to prevent surge and stall conditions.
The forward engine mounts are mounted on the CIC.
The CIC transmits the engine core airflow from the LPC to the HPC.
It supports the bearing No.3 and also provides the ports for the 2.5 stage bleed air flow to join the fan air flow.



ENGINE MODULES - LOW PRESSURE COMPRESSOR AND COMPRESSOR INTERMEDIATE CASE

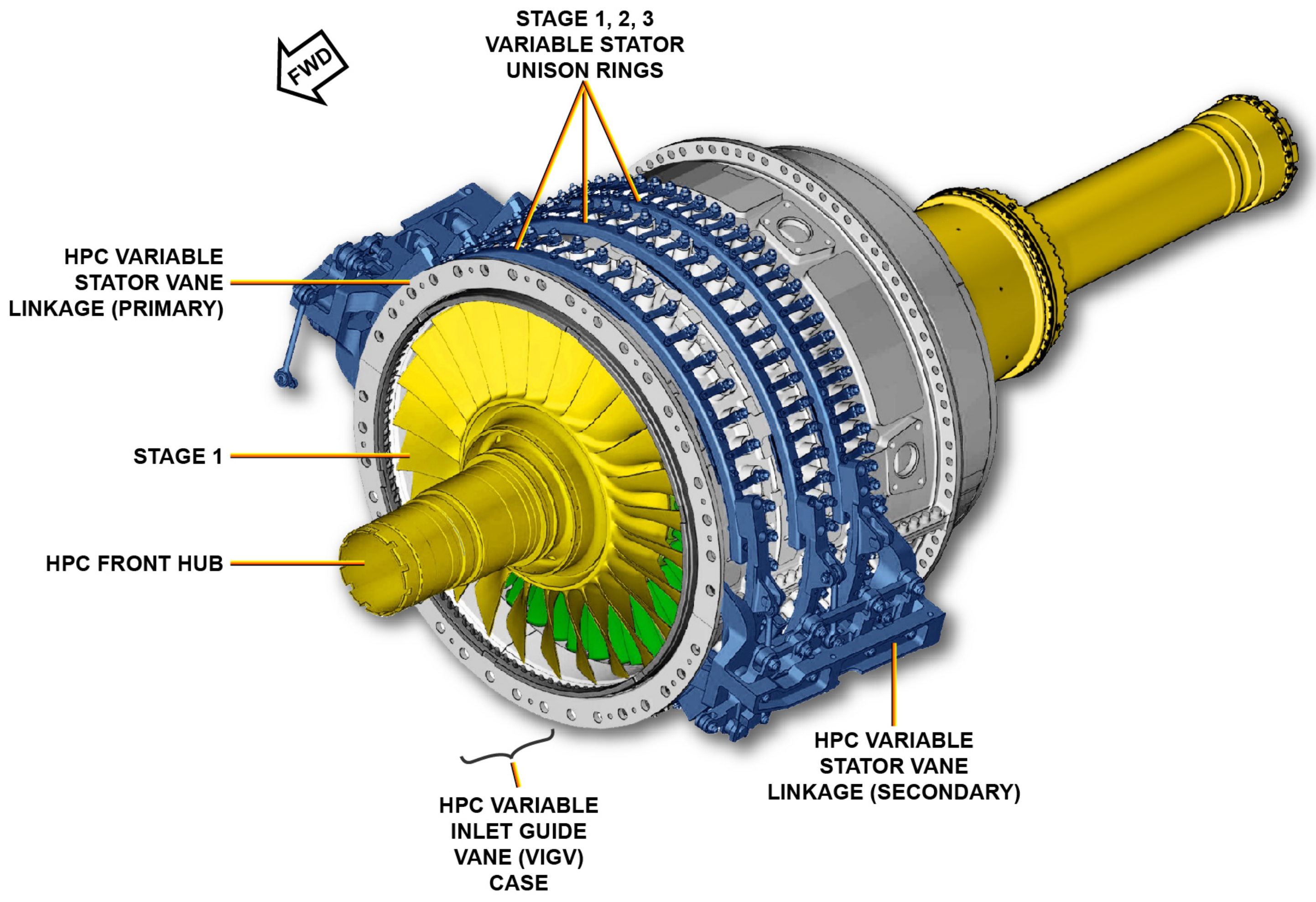
UJ515241 - U08T0MEP - UM72D1PW1100G05

ENGINE SYSTEM D/O (3) (3)

ENGINE MODULES (continued)

HIGH PRESSURE COMPRESSOR ROTOR

The HPC comprises of eight stages axial flow compressor and the shaft which are driven by the HP turbine.
A single stage of Variable Inlet Guide Vane (VIGV) and the first three stages of Variable Stator Vanes (VSVs) of the HPC stators ensure a smooth entry of air to the HPC. Each stage of the variable stators is connected by the unison rings.
The VIGVs and VSV stator vanes are operated by the primary and secondary actuators controlled by the EEC.
The HP Compressor supplies air from Stage 3 and stage 6 to the aircraft systems.



ENGINE MODULES - HIGH PRESSURE COMPRESSOR ROTOR

UJ515241 - U08T0MEP - UM72D1PW1100G05

ENGINE SYSTEM D/O (3) (3)

ENGINE MODULES (continued)

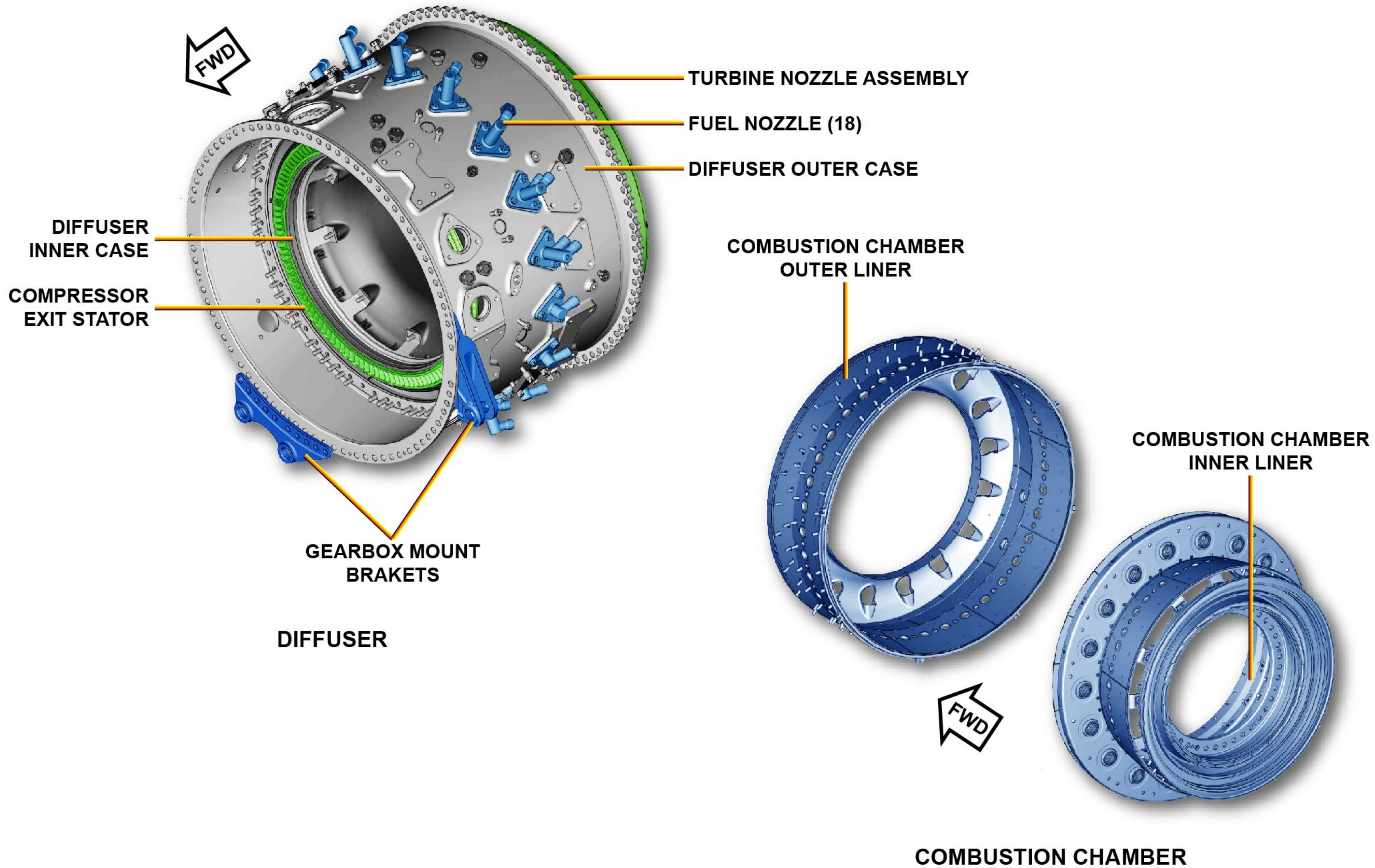
DIFFUSER AND COMBUSTION CHAMBER ASSEMBLY

The unit houses the diffuser, the annular combustion chamber and the turbine nozzle assembly. It also provides the brackets for mounting the Main Gear Box (MGB).

The diffuser converts the kinetic energy of the air coming out of the HPC into pressure energy before it is fed into the combustion chamber.

The annular combustion chamber houses 18 fuel nozzles (6 Simplex and 12 Duplex) and 2 igniter plugs and supports effective combustion of the air/fuel mixture.

The new technology high efficiency design of the combustion chamber also helps in reducing CO2 and NOx emissions.



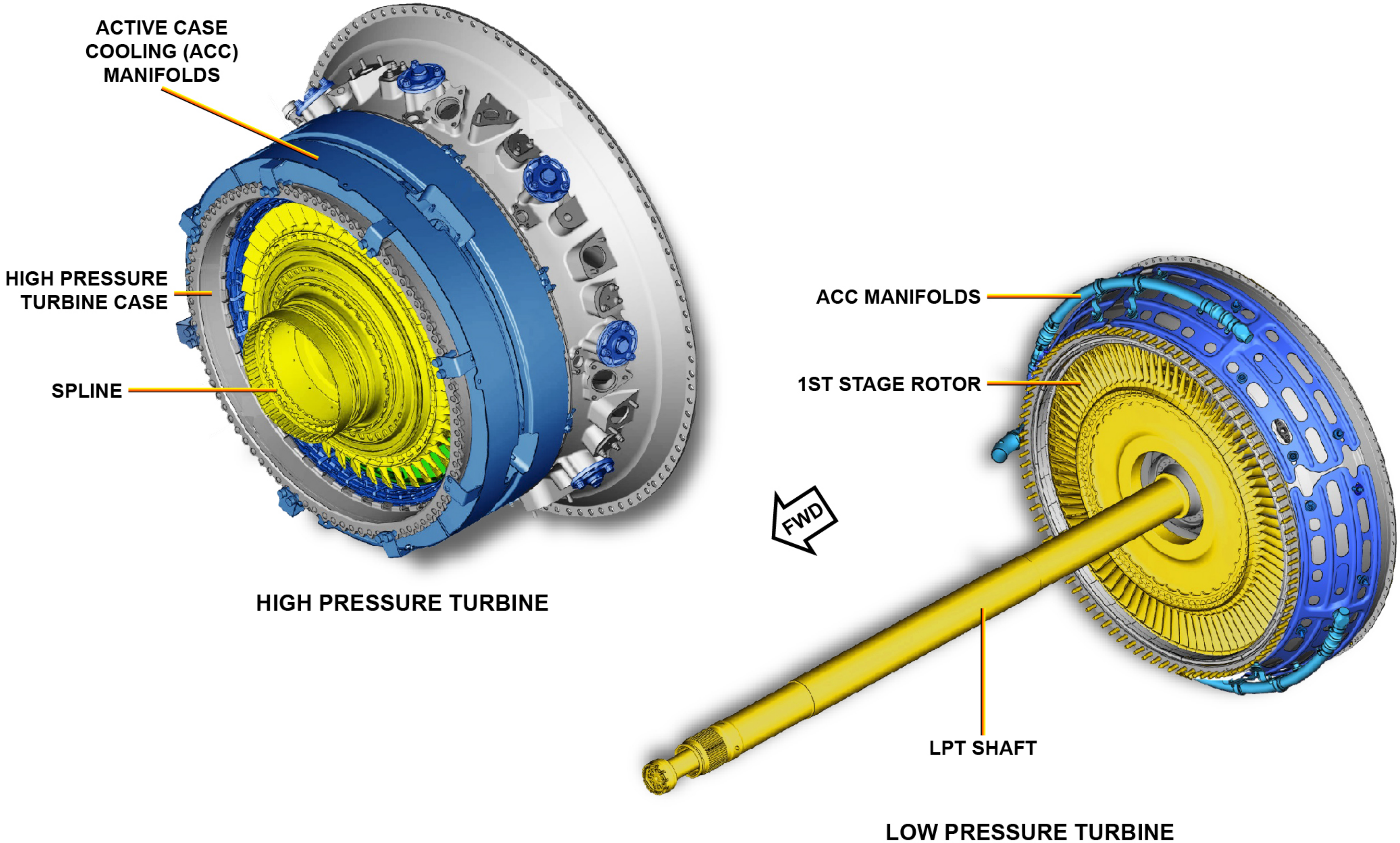
ENGINE MODULES - DIFFUSER AND COMBUSTION CHAMBER ASSEMBLY

ENGINE SYSTEM D/O (3) (3)

ENGINE MODULES (continued)

HIGH PRESSURE AND LOW PRESSURE TURBINES

The HP Turbine is made of two stage axial flow turbine, two stage stator and turbine case.
The HP turbine unit has splines which attaches it to the HP Compressor shaft.
HP Turbine drives the HP Compressor.
Integrated in the HPT assembly is the TIC which directs the HP Turbine airflow to align with the LP Turbine. It supports the n°4 bearing.
The LP Turbine module comprises of three stage rotor assembly, LP rotor shaft, stators and the turbine case.
It drives the LP Compressor and the FDGS.
The HP and LP turbine cases have Active Case Cooling (ACC) cooling manifolds around to control blade tip clearance.



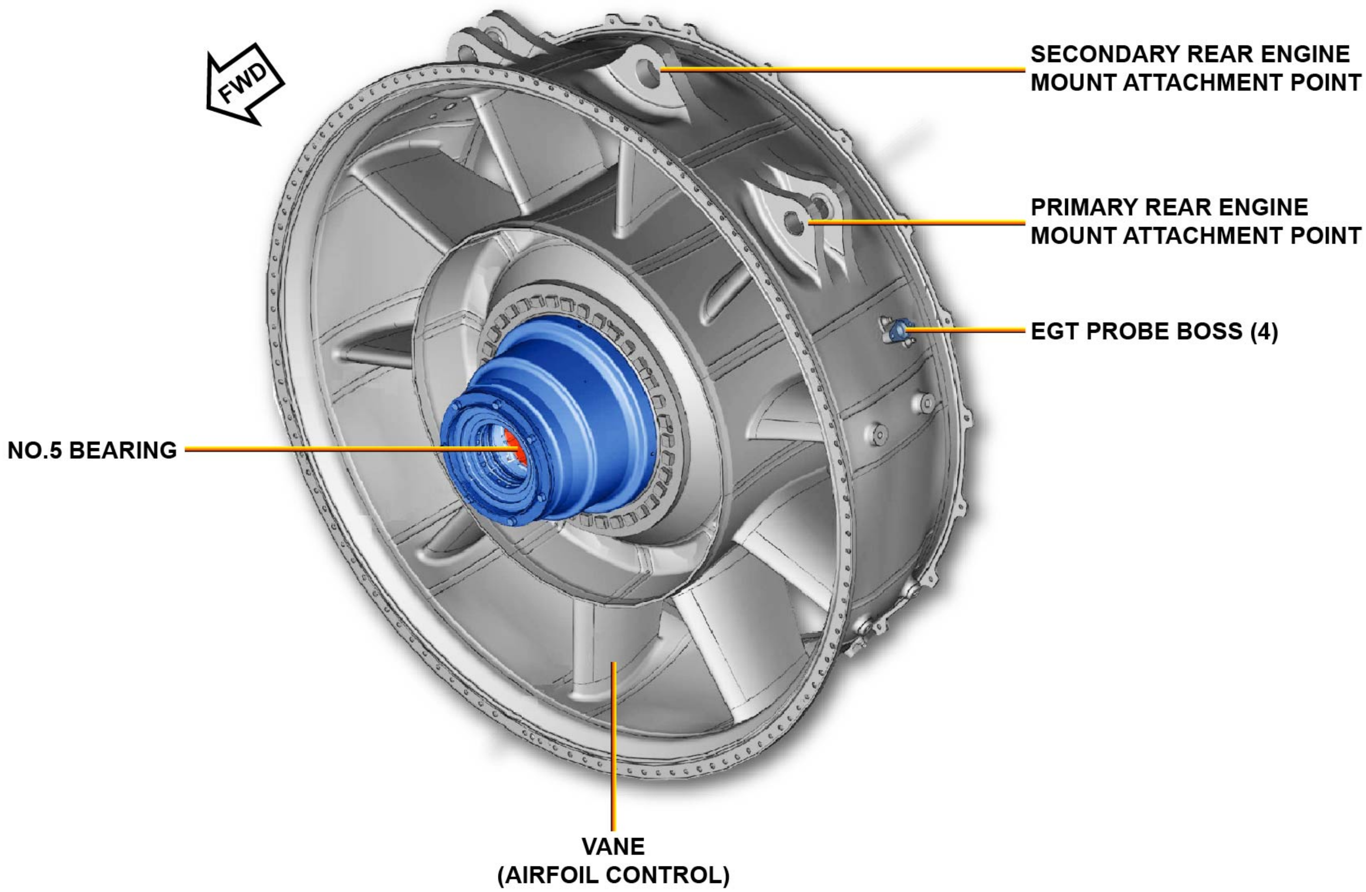
ENGINE MODULES - HIGH PRESSURE AND LOW PRESSURE TURBINES

ENGINE SYSTEM D/O (3) (3)

ENGINE MODULES (continued)

TURBINE EXHAUST CASE

The TEC permits an exit path for the gas flow coming out of the turbines.
It supports the rear roller bearings 5 and 6.
The TEC provides the attachment point for the rear engine mount.
It houses four Exhaust Gas Turbine (EGT) thermocouples.



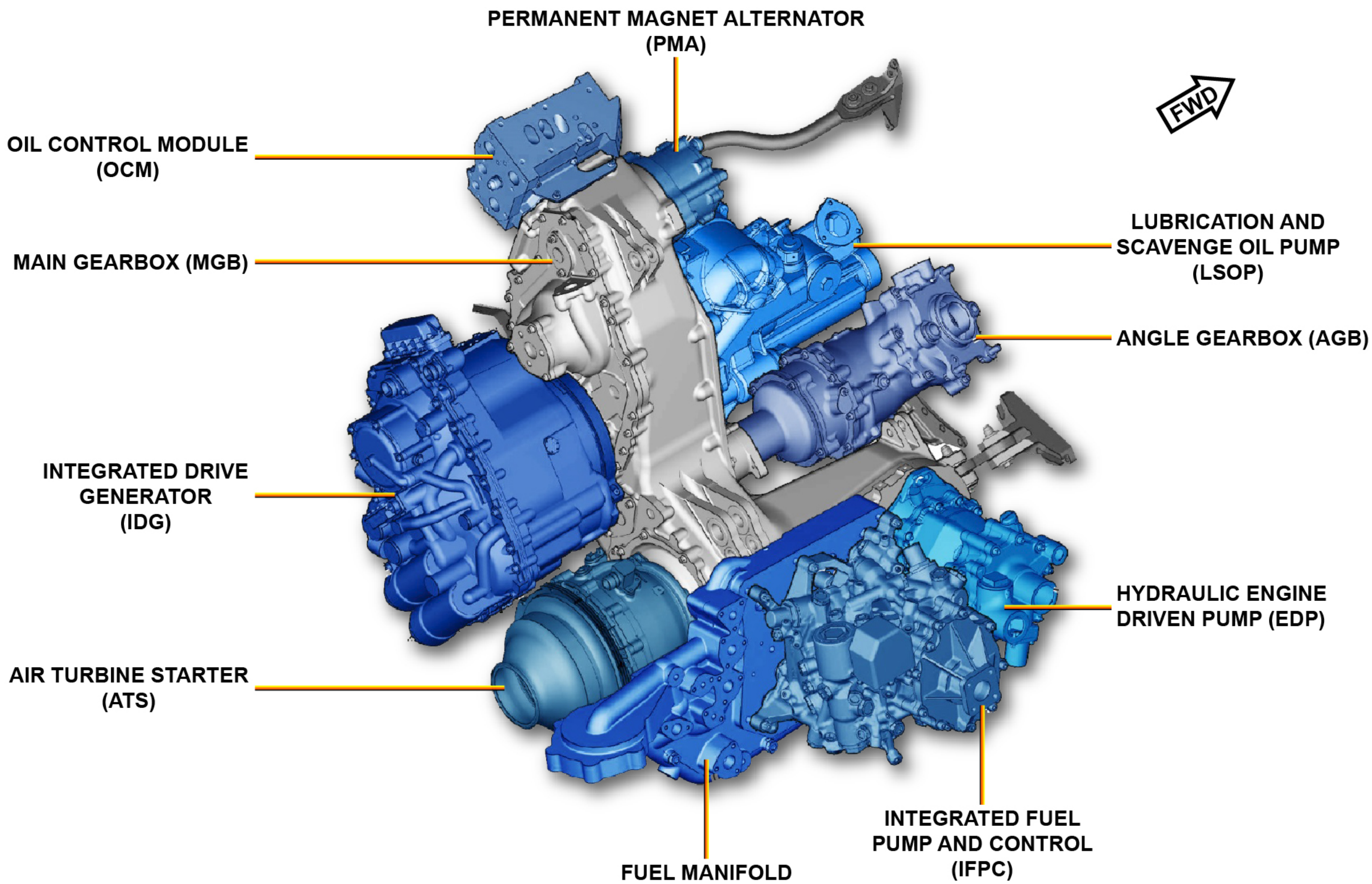
TURBINE EXHAUST CASE

ENGINE MODULES - TURBINE EXHAUST CASE

ENGINE SYSTEM D/O (3) (3)

ENGINE GEAR BOX

The Engine Gear Box (EGB) comprises of two units: the MGB and the Angle Gear Box (AGB).
MGB is attached to the core engine at 4:00 and 9:00.
It provides the drive to the hydraulic pump, Fuel Pump, Integrated Drive Generator (IDG), Permanent Magnet Alternator (PMA) and de-oiler.
A crank pad to turn the HP rotor is located on the LH rear of the MGB.
The Air Starter is mounted on the right side aft of the MGB. During engine start the drive is transmitted through the MGB and AGB to drive the HP Compressor.
The AGB is located forward of the MGB in the core engine area.
The MGB is connected to the AGB through a lay shaft.
The AGB is connected to the HP rotor by bevel gears and the tower shaft.



MAIN GEARBOX WITH ACCESSORIES

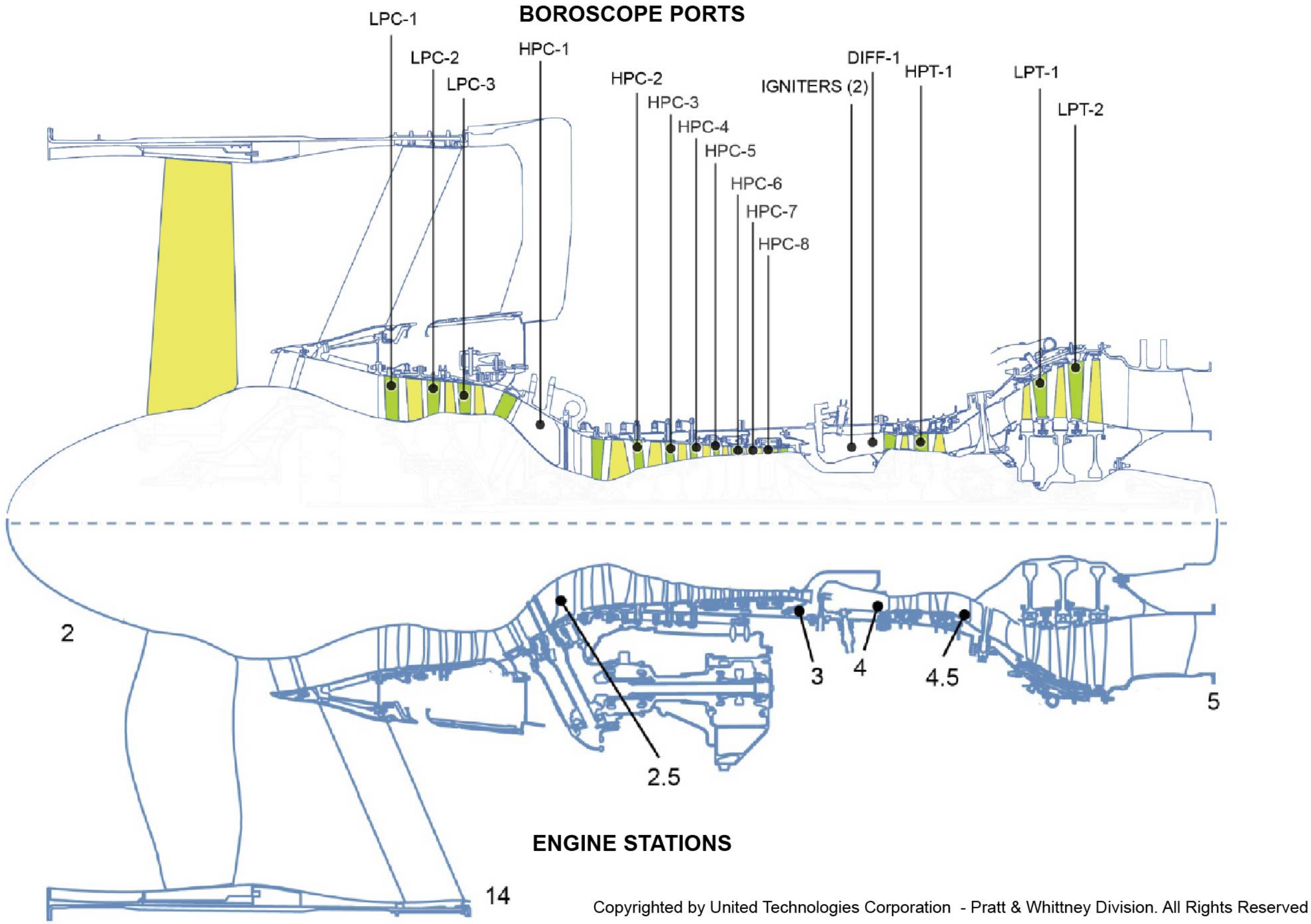
ENGINE GEAR BOX

UJ515241 - U08T0MEP - UM72D1PW1100G05

ENGINE SYSTEM D/O (3) (3)

AERODYNAMIC STATIONS AND BOROSCOPIC PORTS

Several boroscopic ports are provided for preliminary inspection of the gas path without engine disassembly.
Each stage of the rotor, both compressors and turbines have boroscopic ports located at different positions on the engine case.
Igniter plugs ports are used to inspect the combustion chamber liners, fuel nozzles and first stage nozzle guide vanes.
The main aerodynamic stations are identified in the gas path. Some stations have pressure and/or temperature sensors for engine monitoring.

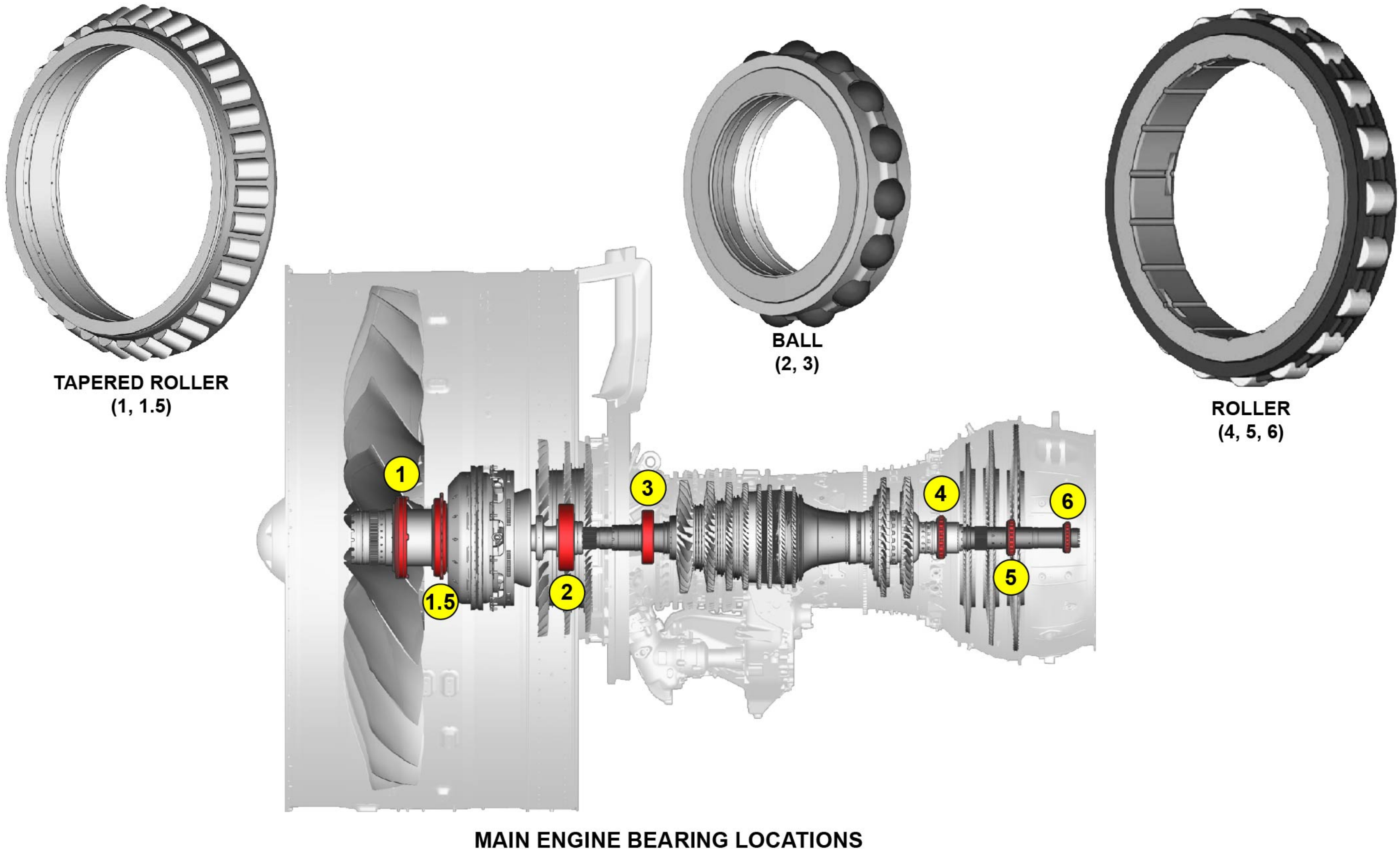


AERODYNAMIC STATIONS AND BOROSCOPIC PORTS

ENGINE SYSTEM D/O (3) (3)

ENGINE BEARINGS

The engine bearings provide reduce rolling friction and supports the rotor axially and radially within the structure.
It bears the different loads of the rotating shaft.
There are five bearing compartments containing a total of seven bearing.
No. 1 and 1.5 are tapered roller bearing and are used to support the fan rotor and FDGS.
No. 2 and 3 are ball bearings and support the front part of LP and HP rotor respectively.
No. 4 is roller bearing and support the rear of N2.
No.5 and 6 are roller bearing and support the rear of N1 rotor.
The bearing compartment are lubricated, cooled and cleaned by engine oil.
Bearing compartments are sealed using carbon seals to prevent oil leakage.

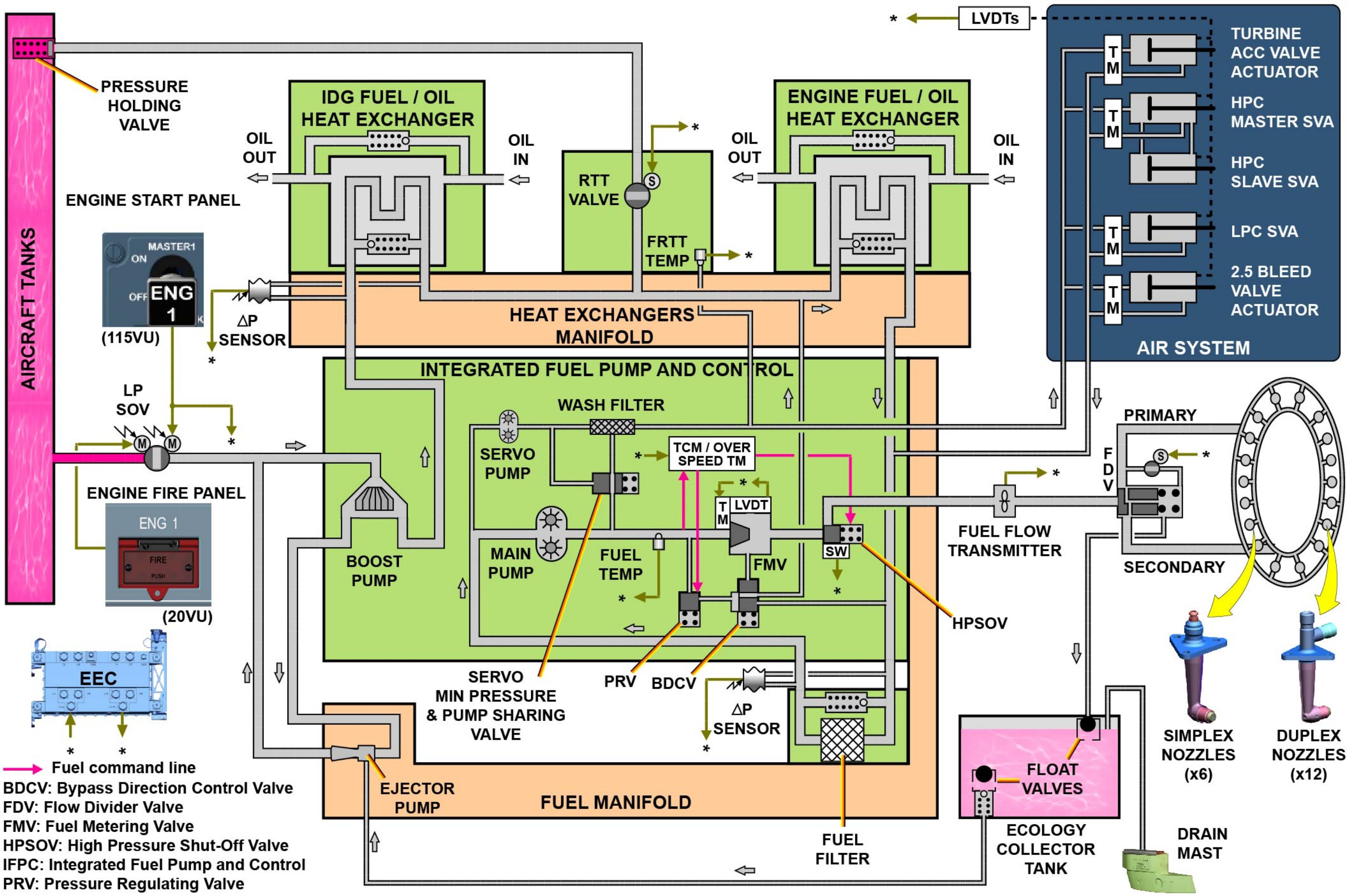


ENGINE BEARINGS

ENGINE FUEL SYSTEM D/O (3)

FUEL DISTRIBUTION

The fuel distribution system supplies fuel from tanks to the engines. The fuel is metered, filtered and supplied at the pressure and flow rate necessary to enable stable engine operations during all the phases. The metered Fuel Flow (FF) is sent to the fuel nozzles for combustion, and pressurized fuel is supplied to the fuel-operated actuators of the engine (e.g. Air valves). The fuel is also heated to prevent ice formation and used to cool engine oil and Integrated Drive Generator (IDG) oil.
The distribution system consists of:
- The Integrated Fuel Pump and Control (IFPC),
- A fuel manifold,
- Fuel/Oil Heat Exchangers (FOHEs),
- A fuel filter,
- Flow Divider Valve (FDV),
- Fuel nozzles,
- Ecology collector tank,
- Return-To-Tank (RTT) valve.



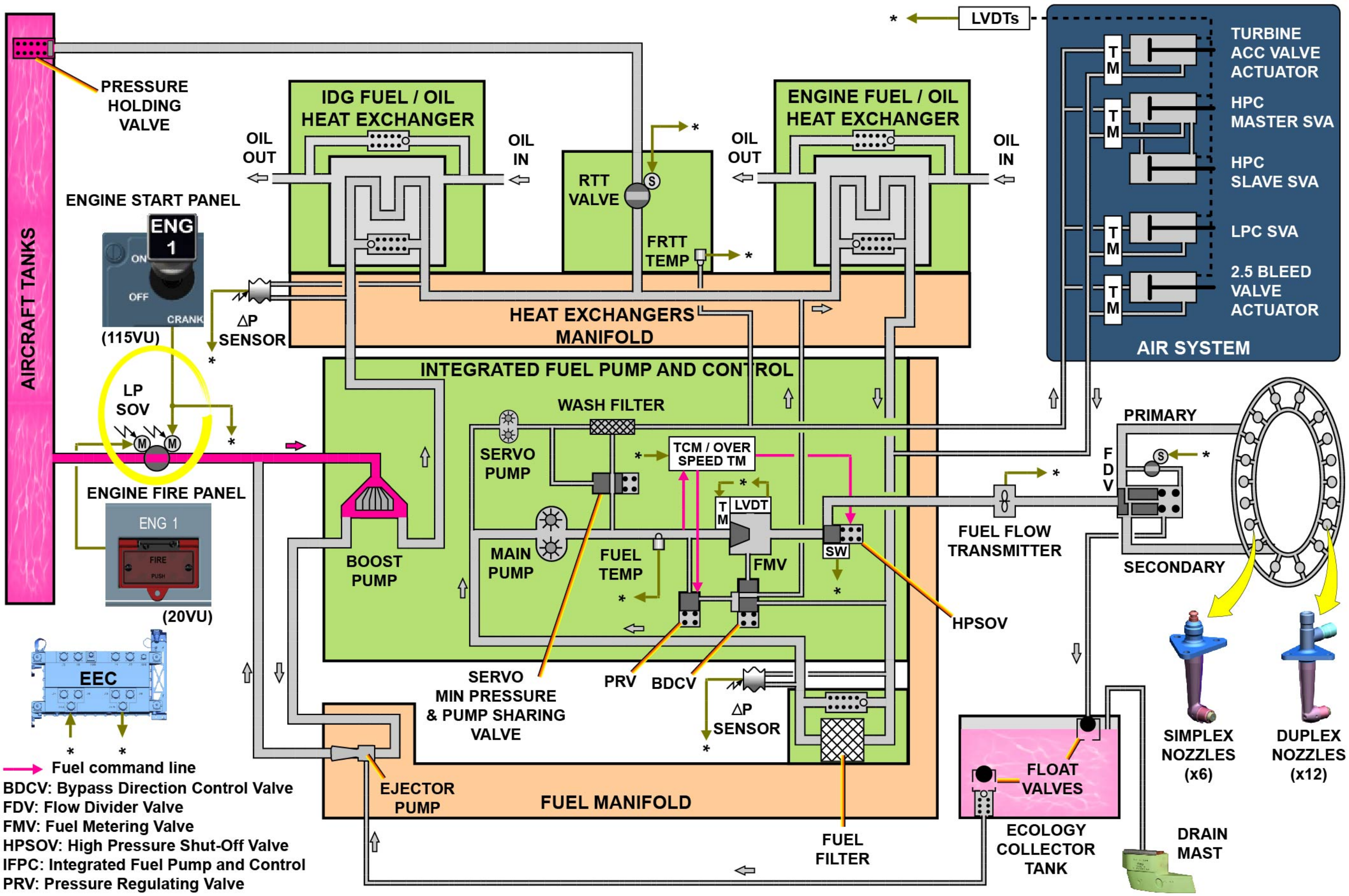
FUEL DISTRIBUTION

UJ515241 - U08T0MEP - UM73D1PW1100G05

ENGINE FUEL SYSTEM D/O (3)

FUEL FEED FROM AIRCRAFT

When the ENGine MASTER Lever is selected ON, the Low Pressure Shut-Off Valve (LPSOV) opens and fuel from the aircraft tanks flows through the main fuel supply line to the inlet port of the boost pump in the IFPC.



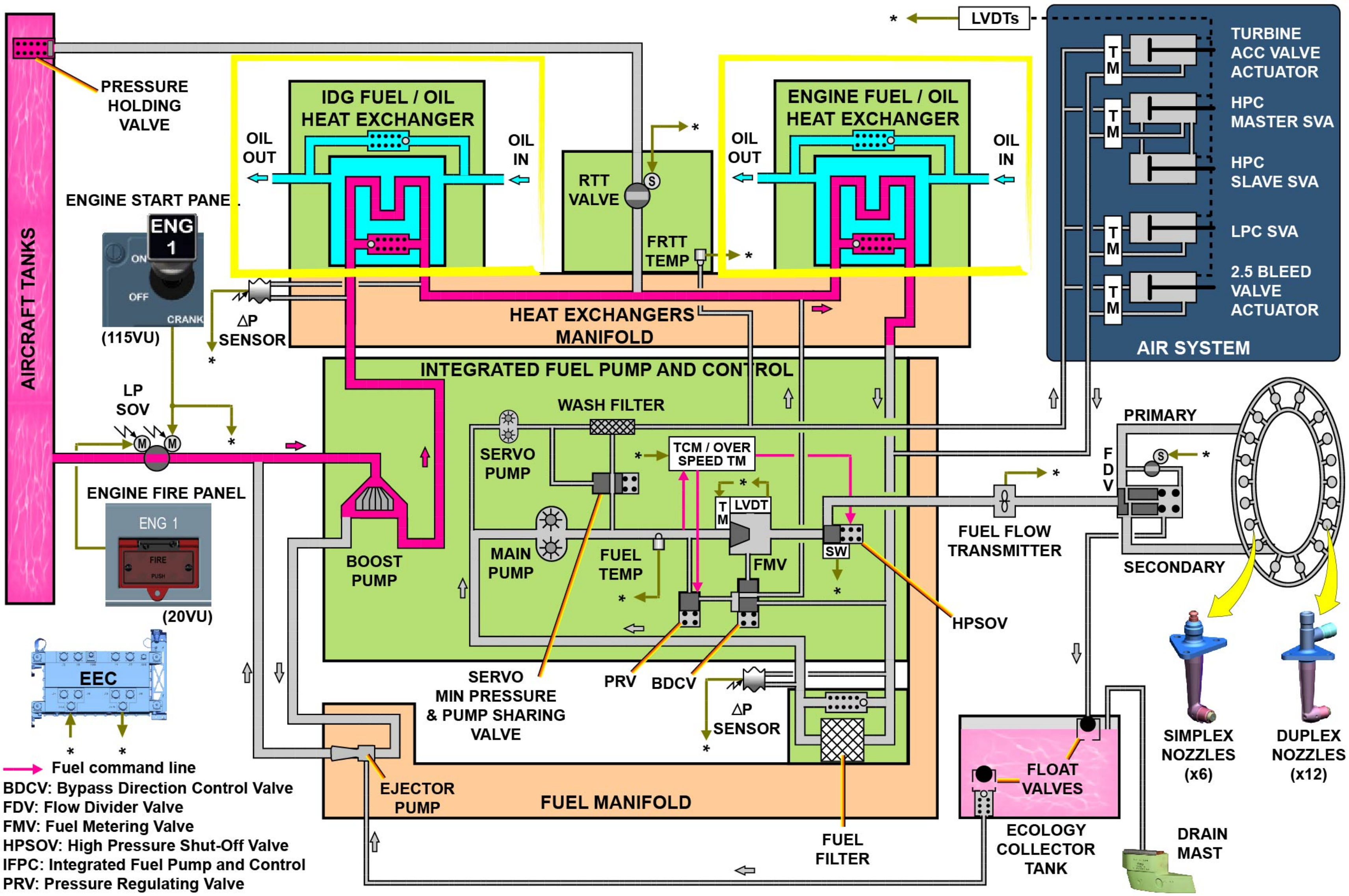
FUEL FEED FROM AIRCRAFT

UJ515241 - U08T0MEP - UM73D1PW1100G05

ENGINE FUEL SYSTEM D/O (3)

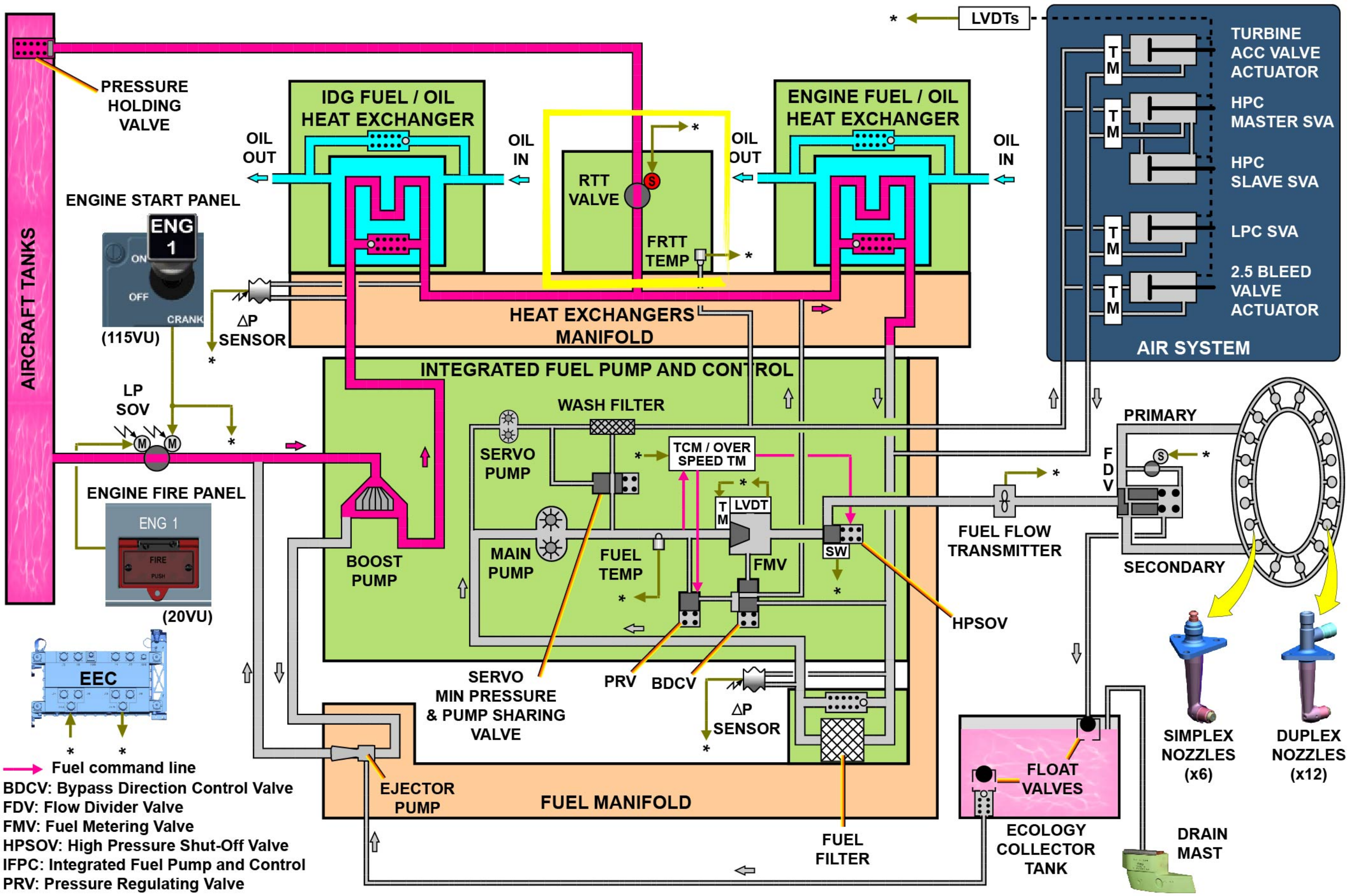
HEAT EXCHANGERS AND FUEL RETURN TO TANK

The boost pump sends LP fuel from the engine fuel supply line to the IDG FOHE. Fuel flow is used to cool down the IDG oil through the IDG FOHE and the engine oil through the engine FOHE. In turn, fuel is heated and de-iced.
Fuel from the engine FOHE is then sent to the fuel filter.
The Fuel Return-To-Tank (FRTT) module contains the Fuel Return Valve (FRV) and the FRTT Temperature sensor.
The FRV controls fuel to flow back to the aircraft tanks from downstream of the IDG FOHE and before it enters the engine FOHE as part of the fuel heat management system. The FRV is controlled by the Electronic Engine Control (EEC) depending on the fuel temperature.



HEAT EXCHANGERS AND FUEL RETURN TO TANK

UJ515241 - U08T0MEP - UM73D1PW1100G05



HEAT EXCHANGERS AND FUEL RETURN TO TANK

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ENGINE FUEL SYSTEM D/O (3)

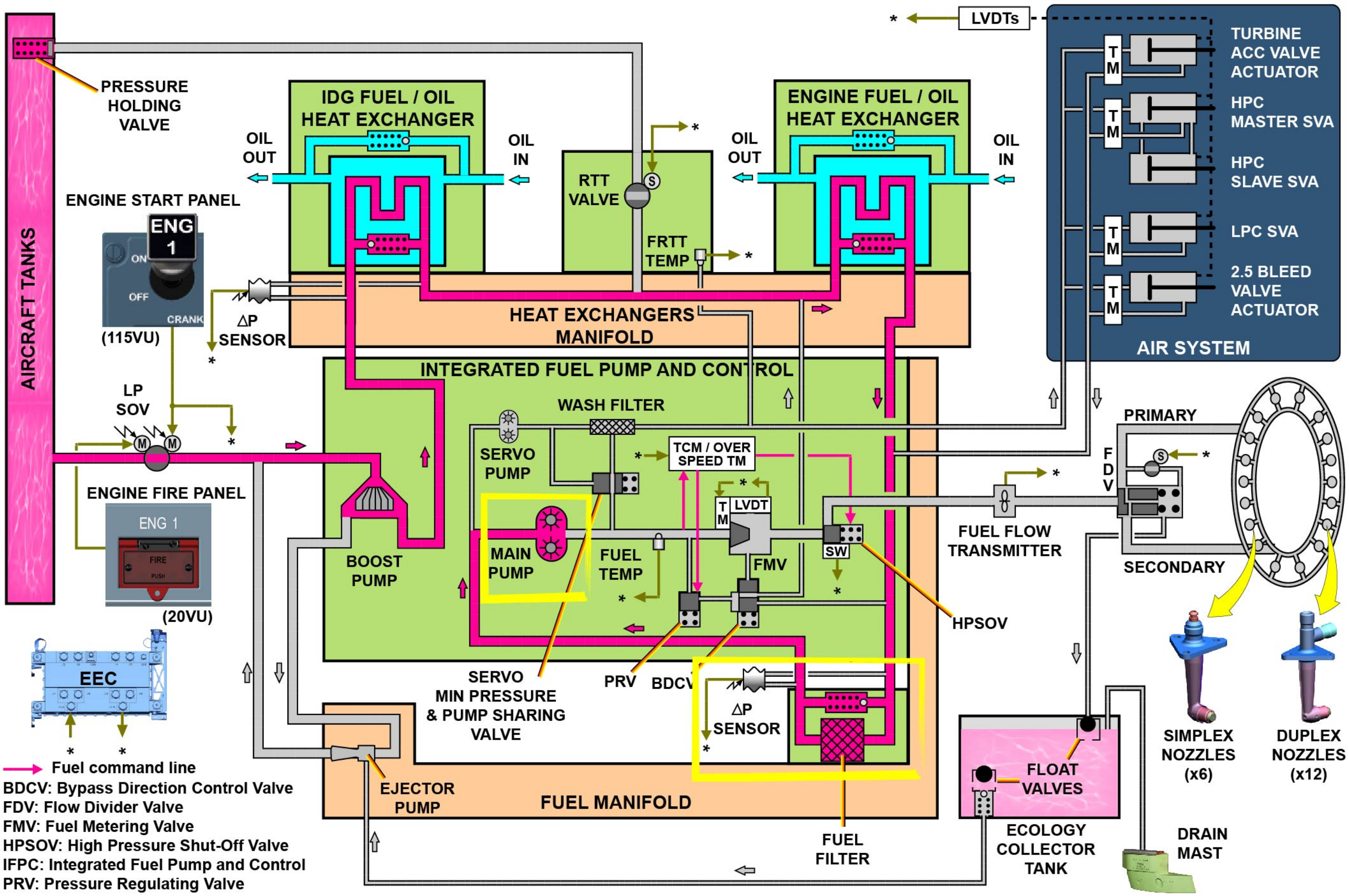
INTEGRATED FUEL PUMP AND CONTROL

The IFPC is an electronically controlled unit which integrates the fuel metering components and the fuel pumps in a single unit to limit the space and the number of external tubes required for the system. The IFPC uses dual coil torque motors and solenoids to control hydro-mechanical valves in relation to the fuel flow. The Main Gearbox (MGB) turns the IFPC input shaft which drives the fuel pump boost-stage, the main fuel pump and servo pump.

FUEL FILTER AND MAIN PUMP

The heated fuel from the engine FOHE is directed through the fuel filter. The filter element is a disposable filter located in a housing attached on the fuel manifold. The filter is monitored by a differential pressure transmitter. The filter housing is fitted with a bypass valve in case of filter element clogging. The filter element is a disposable 25 micron filter.

The fuel exits the fuel filter and flows to the inlet port of the main fuel pump. The main fuel pump is a single-stage gear pump, which increases the fuel pressure and sends the pressurized fuel to the Fuel Metering Valve (FMV).



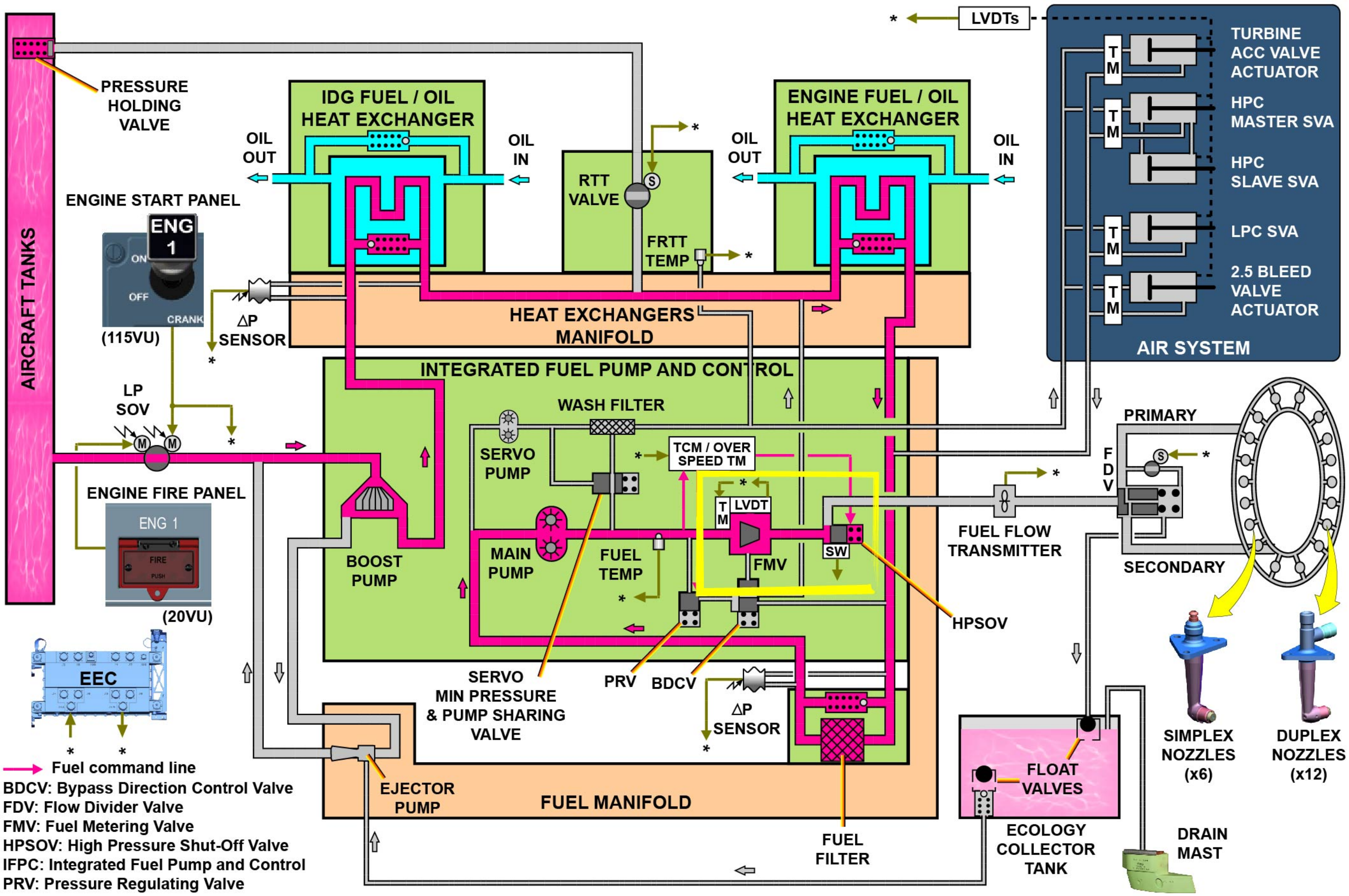
INTEGRATED FUEL PUMP AND CONTROL - FUEL FILTER AND MAIN PUMP

ENGINE FUEL SYSTEM D/O (3)

INTEGRATED FUEL PUMP AND CONTROL (continued)

FUEL METERING VALVE AND HIGH PRESSURE SHUT-OFF VALVE

The EEC controls a dual Torque Motor (TM) which positions the FMV in the desired position. The close loop monitoring is ensured by the EEC using the valve LVDT feedback signals.
The fuel from the FMV is directed to the High Pressure Shut-Off Valve (HPSOV). The fuel pressure at the back side of the HPSOV is controlled by the Thrust Control Malfunction (TCM)/Overspeed TM and allows the valve to open or close.



INTEGRATED FUEL PUMP AND CONTROL - FUEL METERING VALVE AND HIGH PRESSURE SHUT-OFF VALVE

UJ515241 - U08T0MEP - UM73D1PW1100G05

ENGINE FUEL SYSTEM D/O (3)

INTEGRATED FUEL PUMP AND CONTROL (continued)

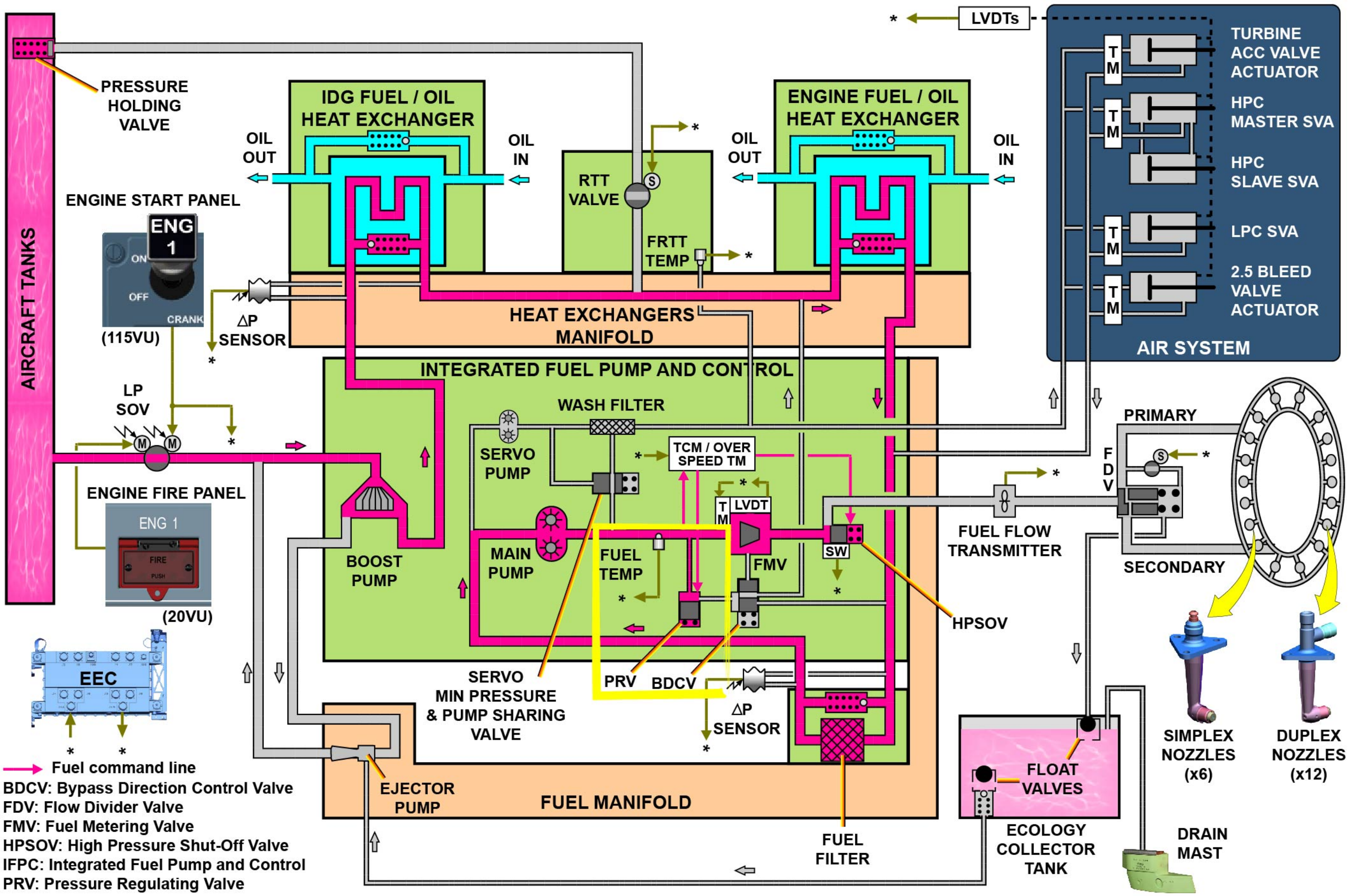
PRESSURE REGULATING VALVE AND BYPASS DIRECTIONAL CONTROL VALVE

Inside the IFPC, the fuel from the main pump is directed to the FMV and to the Pressure Regulating Valve (PRV). The purpose of the PRV is to maintain a constant fuel pressure drop across the FMV to ensure the correct fuel flow and acceleration for the engine.

The TCM/Overspeed TM controls the fuel pressure to the back side of the PRV to modulate fuel flow between the FMV and the Bypass Directional Control Valve (BDCV).

Pressurized fuel that passes through the PRV is directed to the BDCV. The BDCV directs fuel by-passed by the PRV to the engine FOHE at low engine power or when the fuel temperature is low to help in maintaining the engine oil and fuel within operating limits.

At high power, the BDCV returns the recirculation flow downstream of the FOHE.



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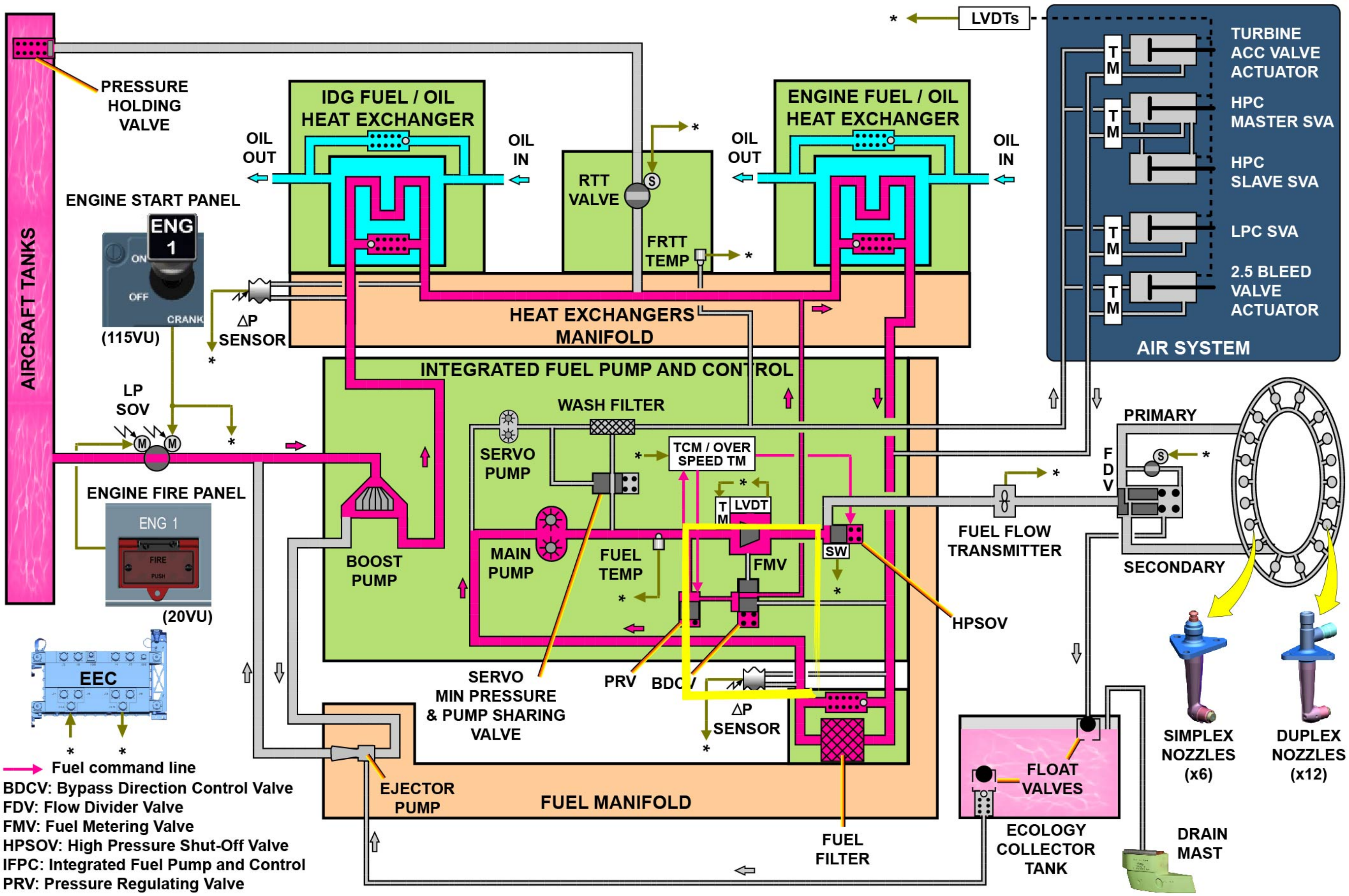
INTEGRATED FUEL PUMP AND CONTROL - PRESSURE REGULATING VALVE AND BYPASS DIRECTIONAL CONTROL VALVE



INTEGRATED FUEL PUMP AND CONTROL - PRESSURE REGULATING VALVE AND BYPASS DIRECTIONAL CONTROL VALVE

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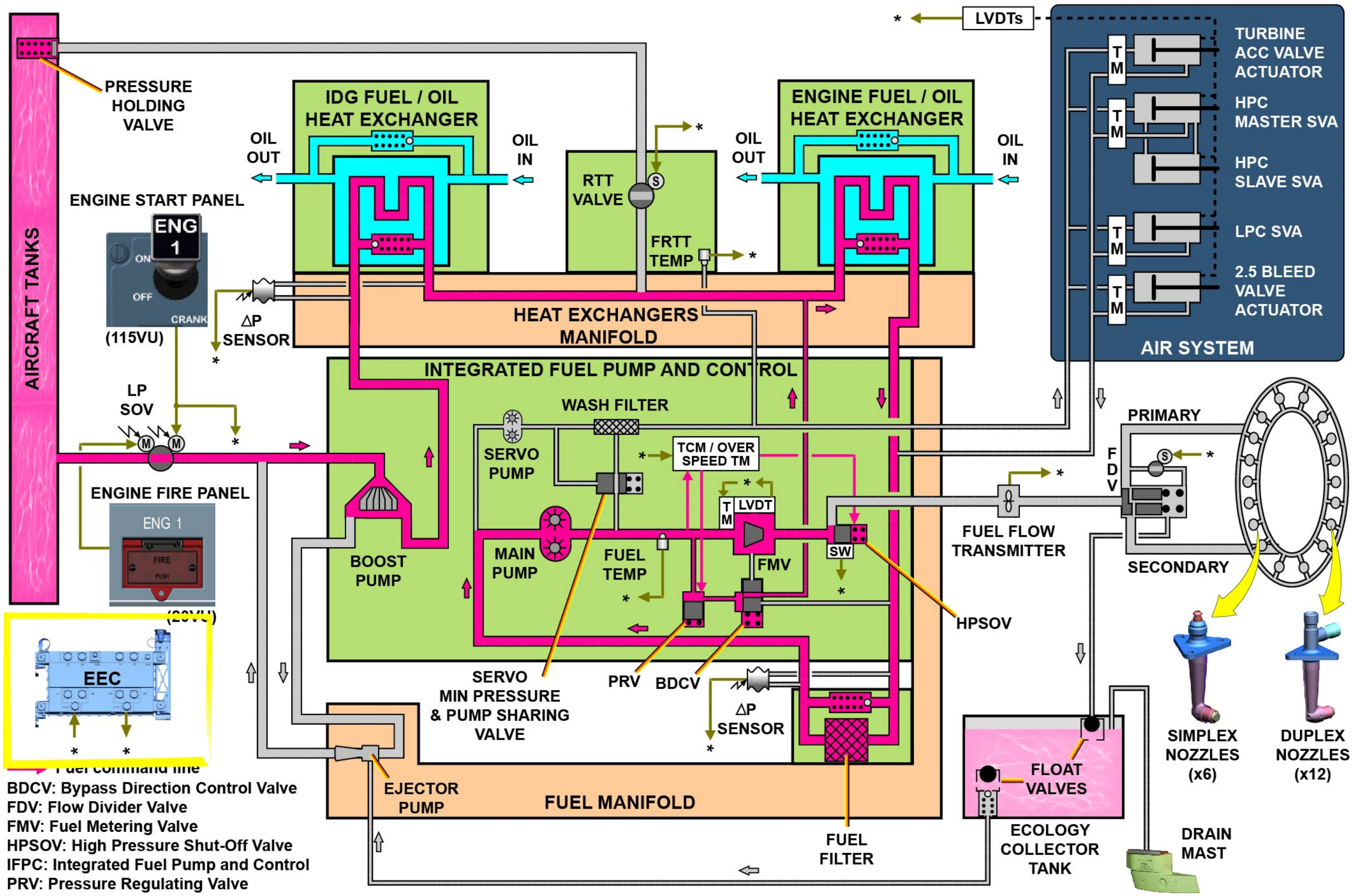
ENGINE FUEL SYSTEM D/O (3)

INTEGRATED FUEL PUMP AND CONTROL (continued)

EEC CONTROL

The EEC controls the dual TCM/Overspeed TM for HPSOV positioning.
It monitors the valve fully closed position with the two proximity switches.
The EEC also controls the FMV position via a dual channel Torque Motor (TM).
A dual channel Linear Variable Differential Transducer (LVDT) provides the FMV position to the EEC.
For the air system, the EEC controls the fuel-operated actuators with dual channel TMs and it monitors their position thanks to LVDT position feedbacks.



INTEGRATED FUEL PUMP AND CONTROL - EEC CONTROL

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ENGINE FUEL SYSTEM D/O (3)

FUEL FLOW TRANSMITTER, FLOW DIVIDER VALVE AND FUEL NOZZLES

The metered fuel from the FMV crosses the HPSOV and flows to the fuel flow transmitter.
The fuel flow transmitter sends the fuel flow rate to the EEC channel A and directs fuel to the Flow Divider Valve (FDV).
The EEC commands the FDV opening during starting to improve fuel atomization.
During engine start, the FDV sends most of fuel to the primary manifold.
Above idle, the FDV evenly divides metered fuel flow between the primary and secondary fuel manifolds.
At shutdown, the FDV is spring loaded closed to allow primary and secondary manifold drainage.
The FDV is fitted with a metal screen strainer that can be bypassed in case of blockage.
There are 18 fuel nozzles mounted to the outer diffuser case. All the nozzles atomize fuel inside the combustor.
Twelve of them are duplex nozzles featuring both a primary and a secondary fuel flow paths while six others are simplex nozzles providing only a secondary fuel flow path.

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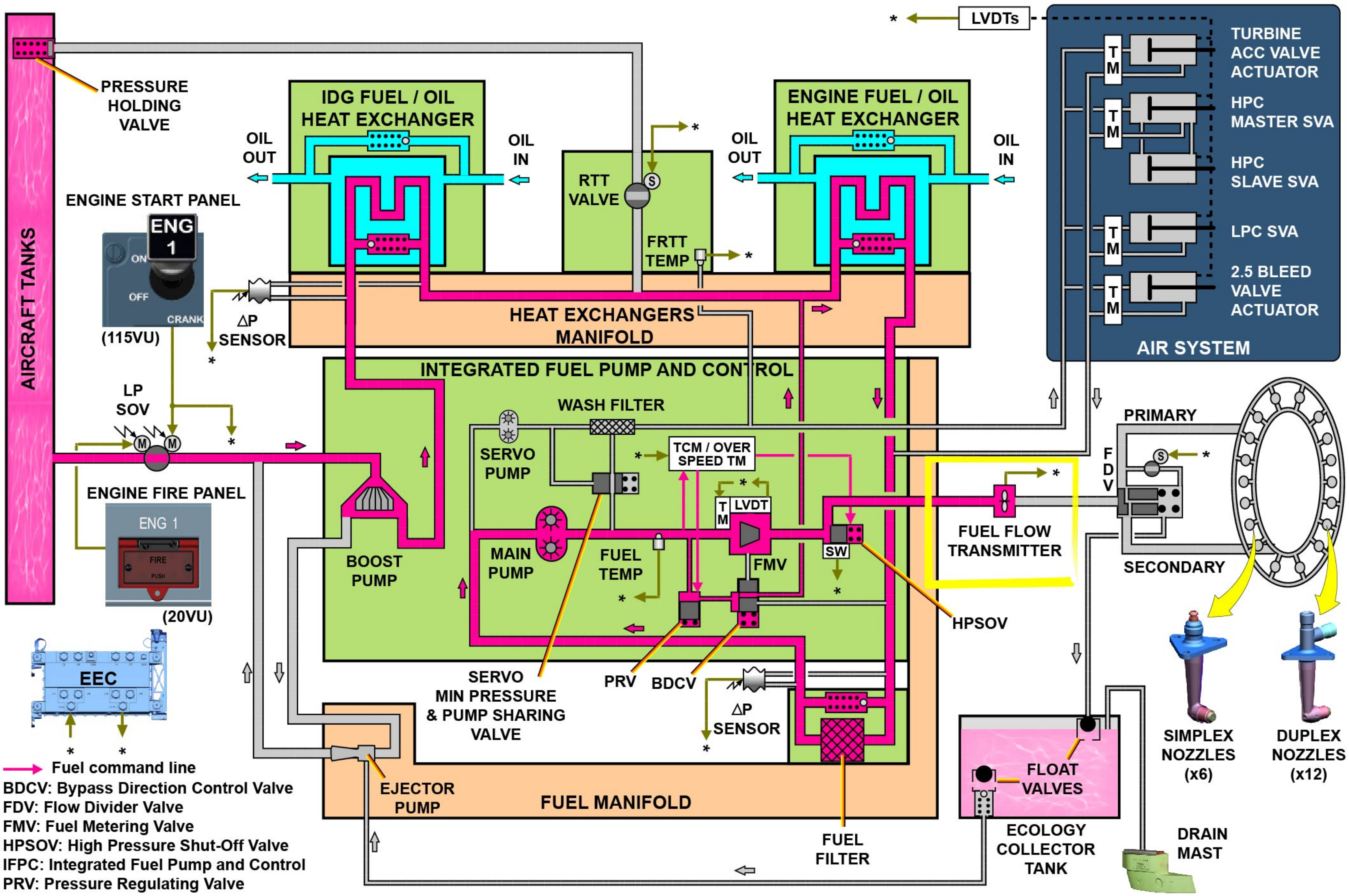
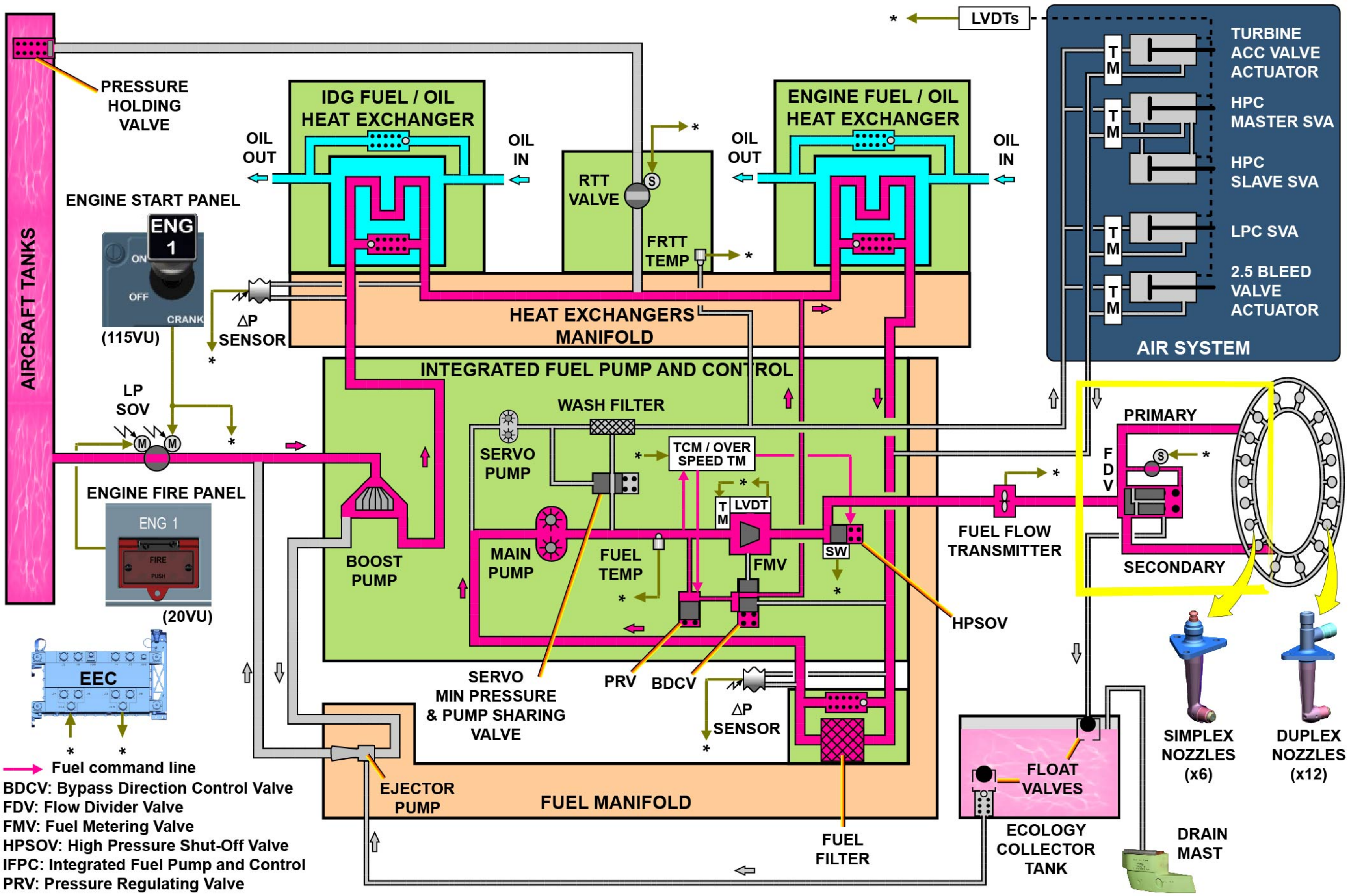
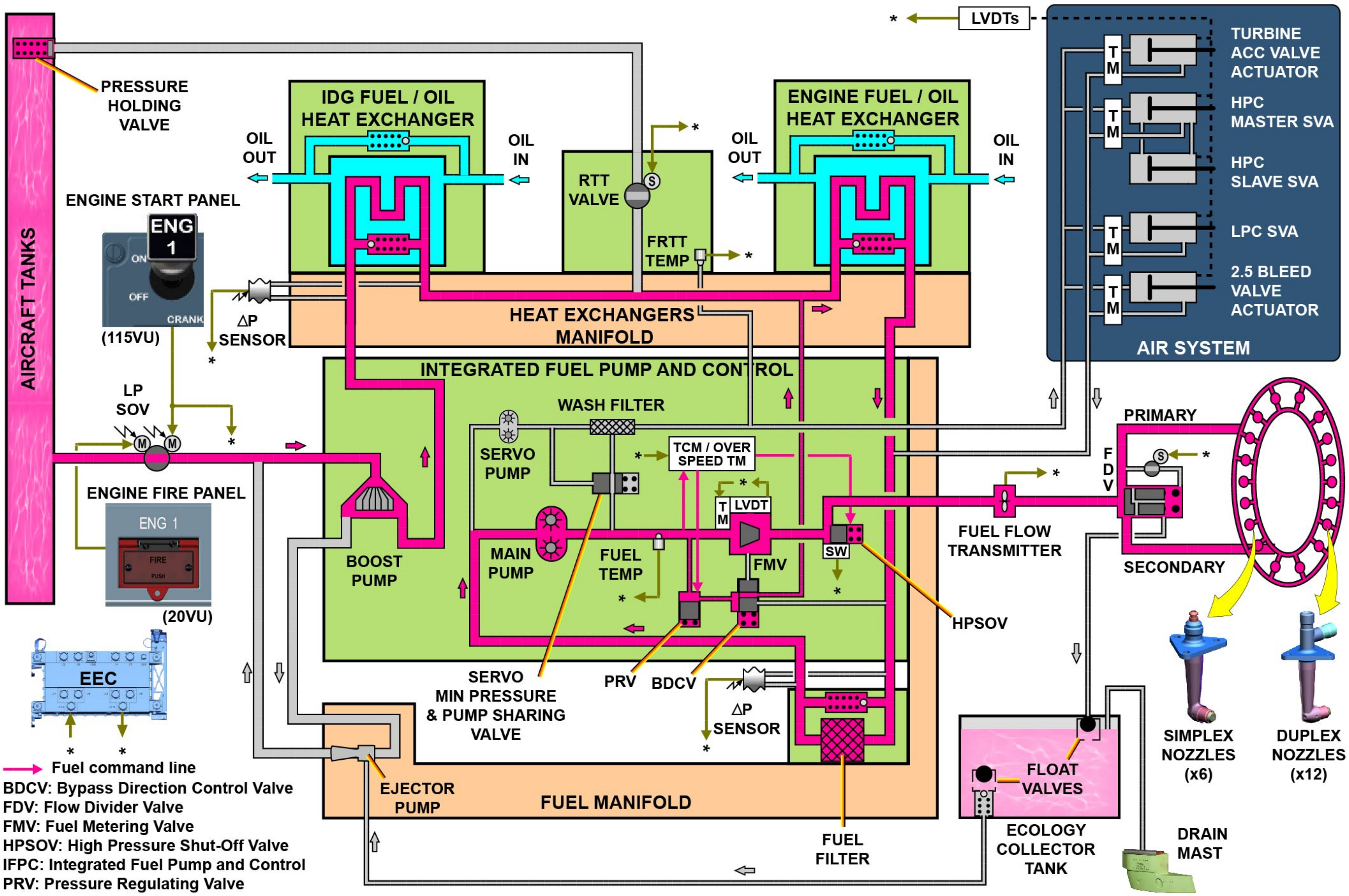


FUEL FLOW TRANSMITTER, FLOW DIVIDER VALVE AND FUEL NOZZLES



FUEL FLOW TRANSMITTER, FLOW DIVIDER VALVE AND FUEL NOZZLES



FUEL FLOW TRANSMITTER, FLOW DIVIDER VALVE AND FUEL NOZZLES

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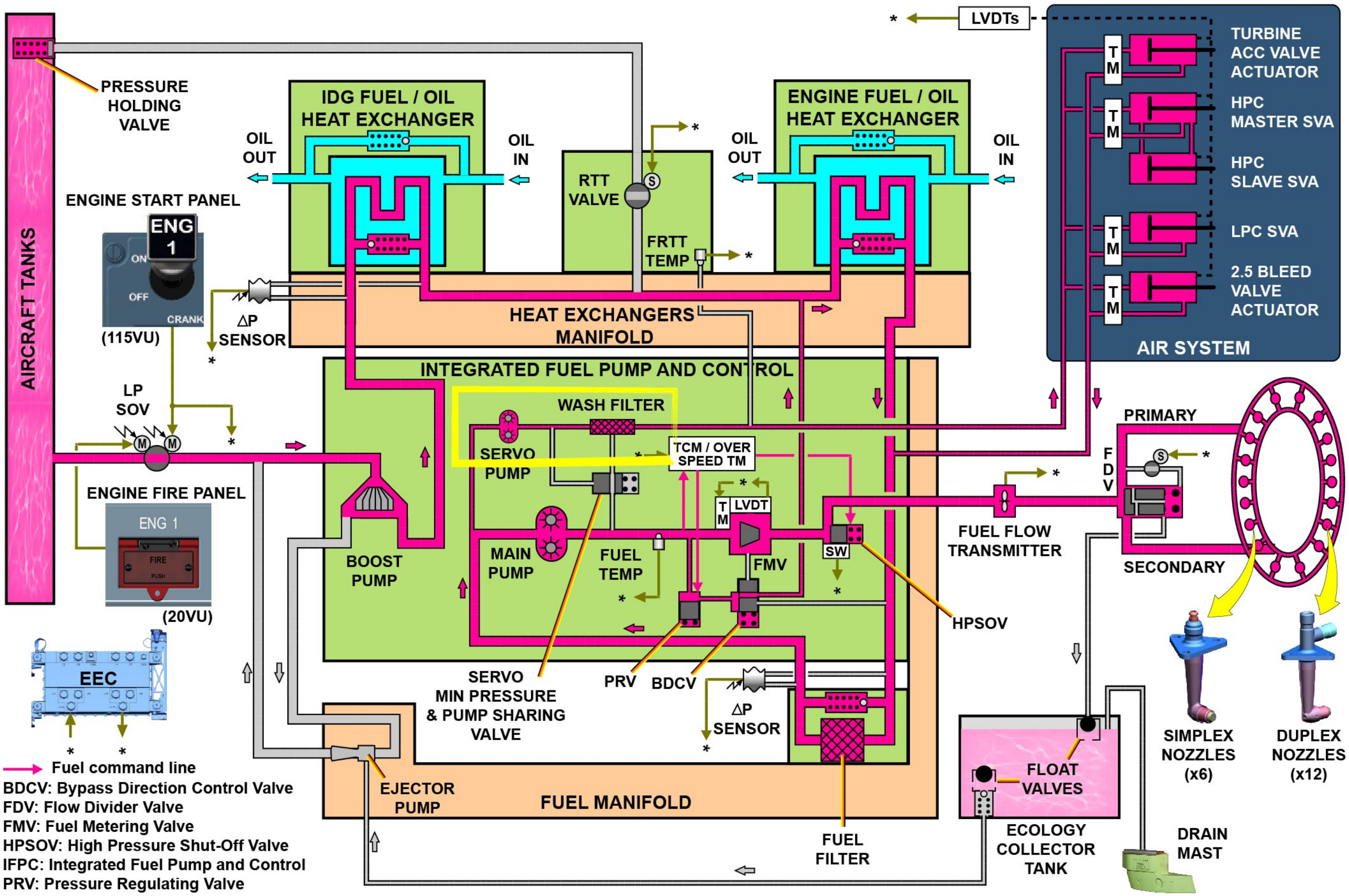
ENGINE FUEL SYSTEM D/O (3)

SERVO FUEL AND SERVO MINIMUM PRESSURE AND PUMP SHARING VALVE

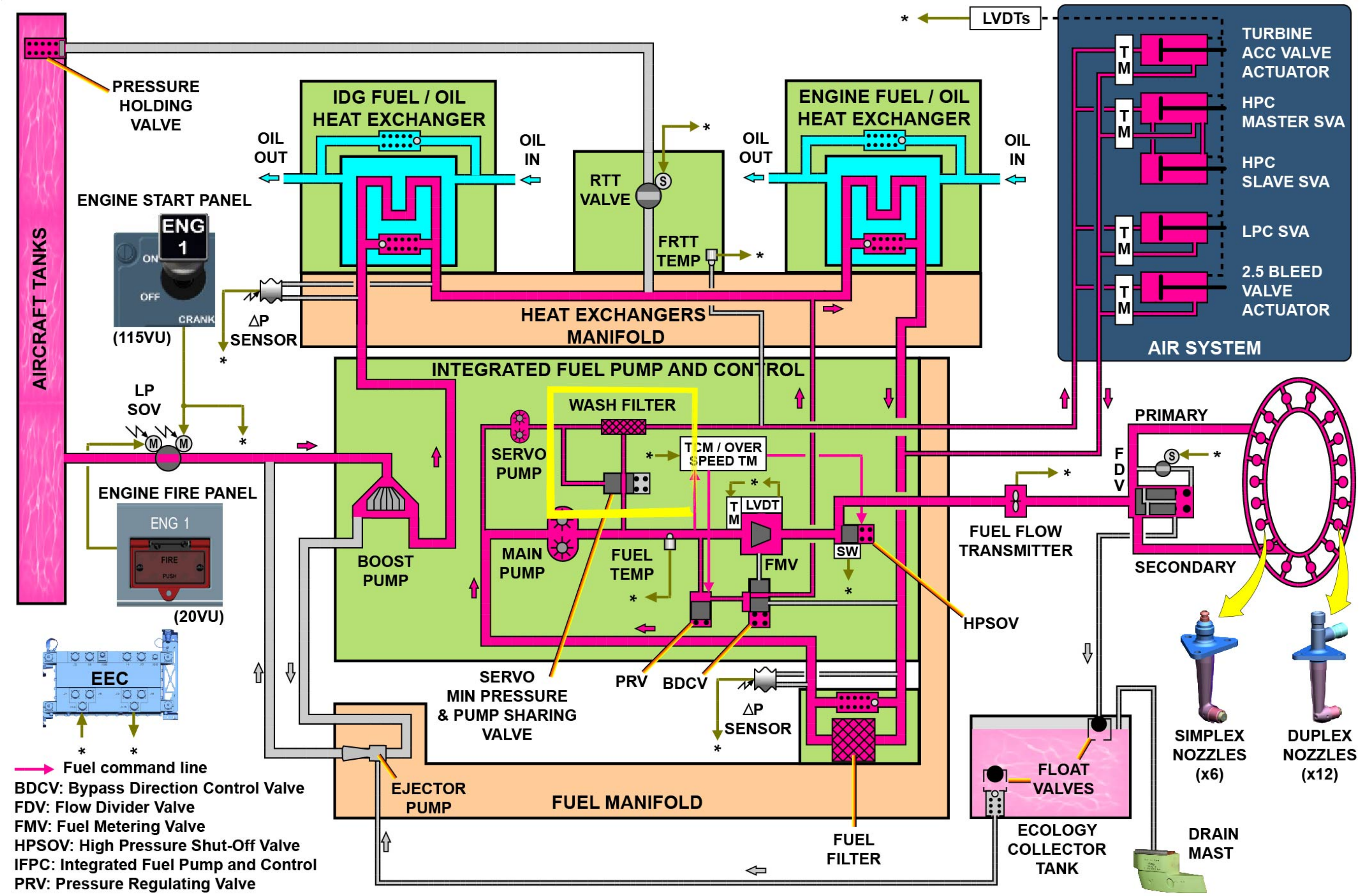
The servo pump housed in the IFPC is a gear-stage pump which sends pressurized fuel to a wash filter. Fine filtered, pressurized fuel from the wash filter is supplied to the engine air system actuators where it is used as servo and muscle pressure to position the actuator pistons.
These actuators are:
- the Low Pressure Compressor (LPC) Stator Vane Actuator (SVA),
- the LPC (2.5) Bleed Valve Actuator (BVA),
- the turbine Active Case Cooling (ACC) valve,
- and the High-Pressure Compressor (HPC) SVAs (primary and secondary).

The fuel from the actuators is filtered again before it returns back to main pump and servo pump inlet.
The Servo Minimum Pressure and Pump Sharing Valve is a spring loaded valve that provides the five air system actuators with main pump fuel pressure when servo pump fuel pressure is not enough during start.



SERVO FUEL AND SERVO MINIMUM PRESSURE AND PUMP SHARING VALVE

UJ515241 - U08T0MEP - UM73D1PW1100G05



SERVO FUEL AND SERVO MINIMUM PRESSURE AND PUMP SHARING VALVE

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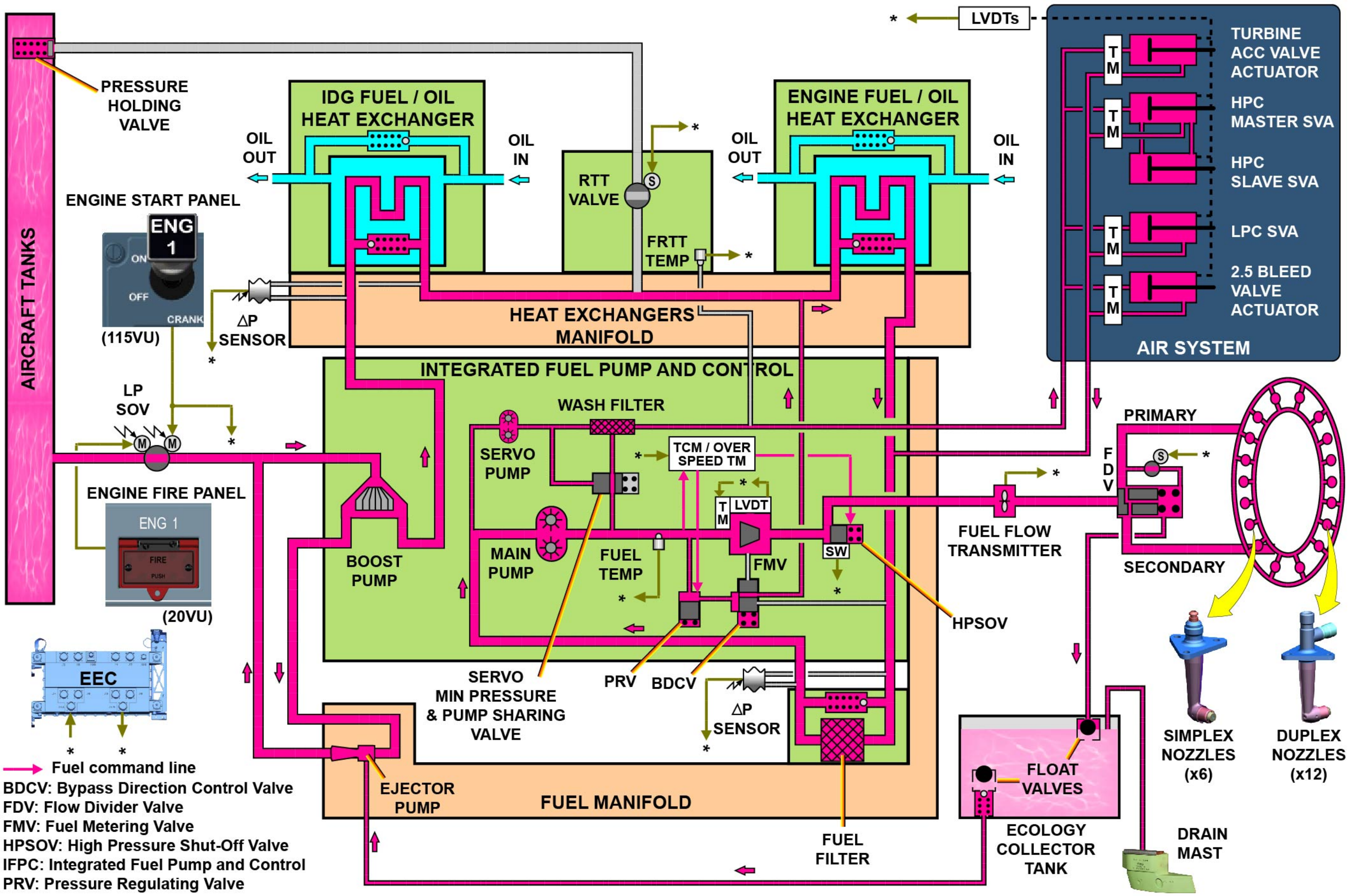
ENGINE FUEL SYSTEM D/O (3)

ECOLOGY SYSTEM

At engine shutdown, residual fuel in the manifolds downstream of the FDV is drained back through the FDV to an ecology collector tank.
The collected fuel remains in the ecology collector tank until the next engine start when the fuel is drawn back into the fuel system.
During shutdown, the fuel pressure from the IFPC is reduced and the FDV closes to prevent fuel from entering the combustor and to drain any fuel remaining in both the primary and secondary fuel lines to the ecology collector tank.
The ecology collector tank has enough space to receive fuel from a single engine shutdown. The tank has an inlet float valve which closes when the tank has reached its maximum capacity. This prevents the tank from overfilling and spilling fuel out following an aborted start.
At next engine start up, the ejector pump draws the fuel from the ecology collector tank back to the IFPC boost pump. The tank has an outlet float valve which closes when the tank has reached its minimum capacity and a check valve to avoid fuel transfer from the suction line.



ECOLOGY SYSTEM

UJ515241 - U08T0MEP - UM73D1PW1100G05

ENGINE FUEL SYSTEM D/O (3)

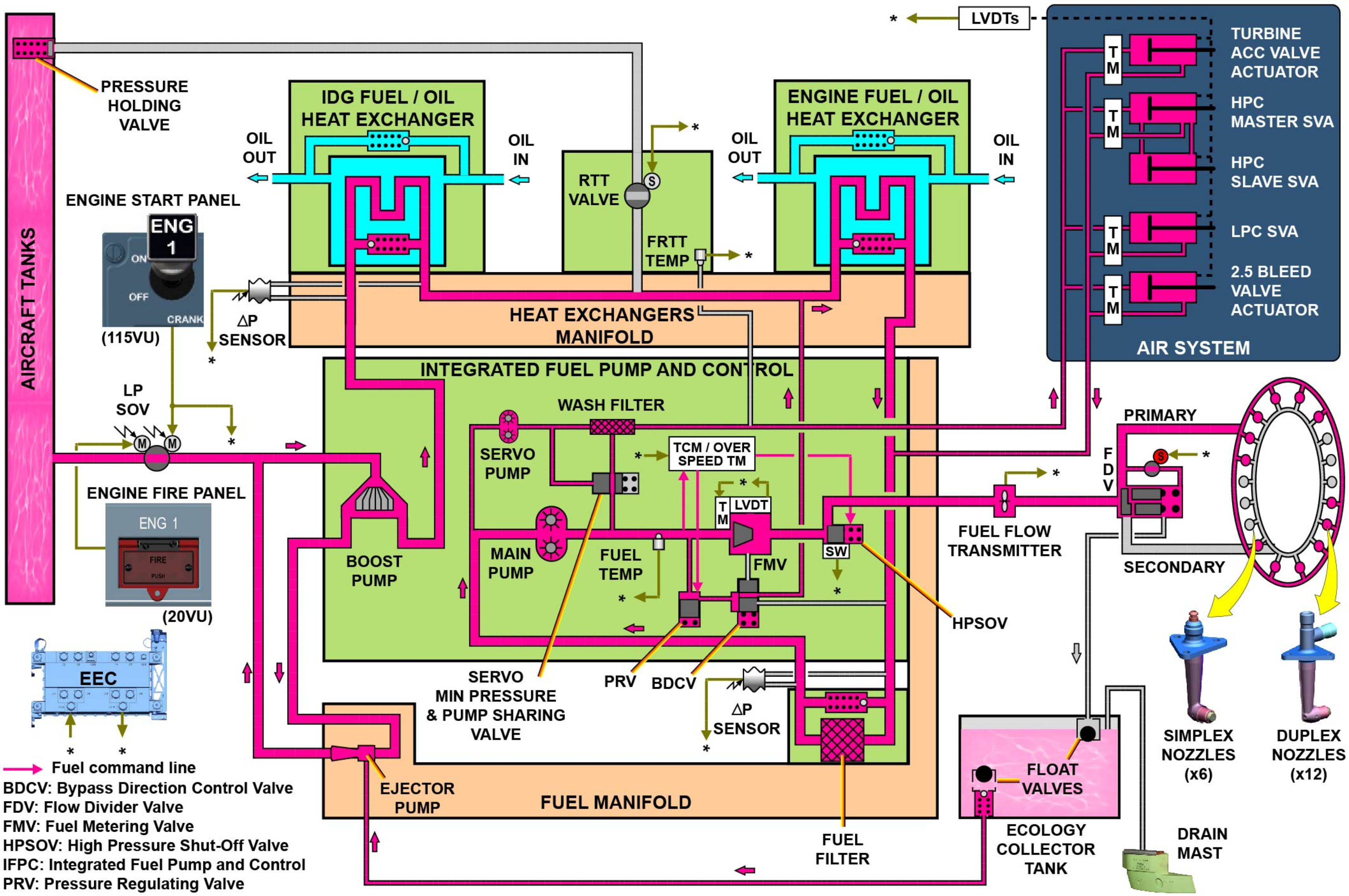
STARTING

INITIATION

During starting, the servo pump fuel pressure is not enough to control the air system actuators and to close the Servo Minimum Pressure and Pump Sharing Valve. In this position, the Servo Minimum Pressure and Pump Sharing Valve directs a portion of pressurized fuel from the main pump to the five actuators. The other portion of fuel from the main pump is sent to the PRV and to the FMV. The PRV opens partly and directs the excess of fuel flow to the BDCV which is spring loaded to send it to the engine FOHE.

The EEC opens the FMV and let the fuel to flow to the HPSOV which also opens and sends fuel to the fuel flow transmitter.

The pressurized fuel opens the FDV. The FDV partly opens and sends most of fuel to the primary fuel nozzles.



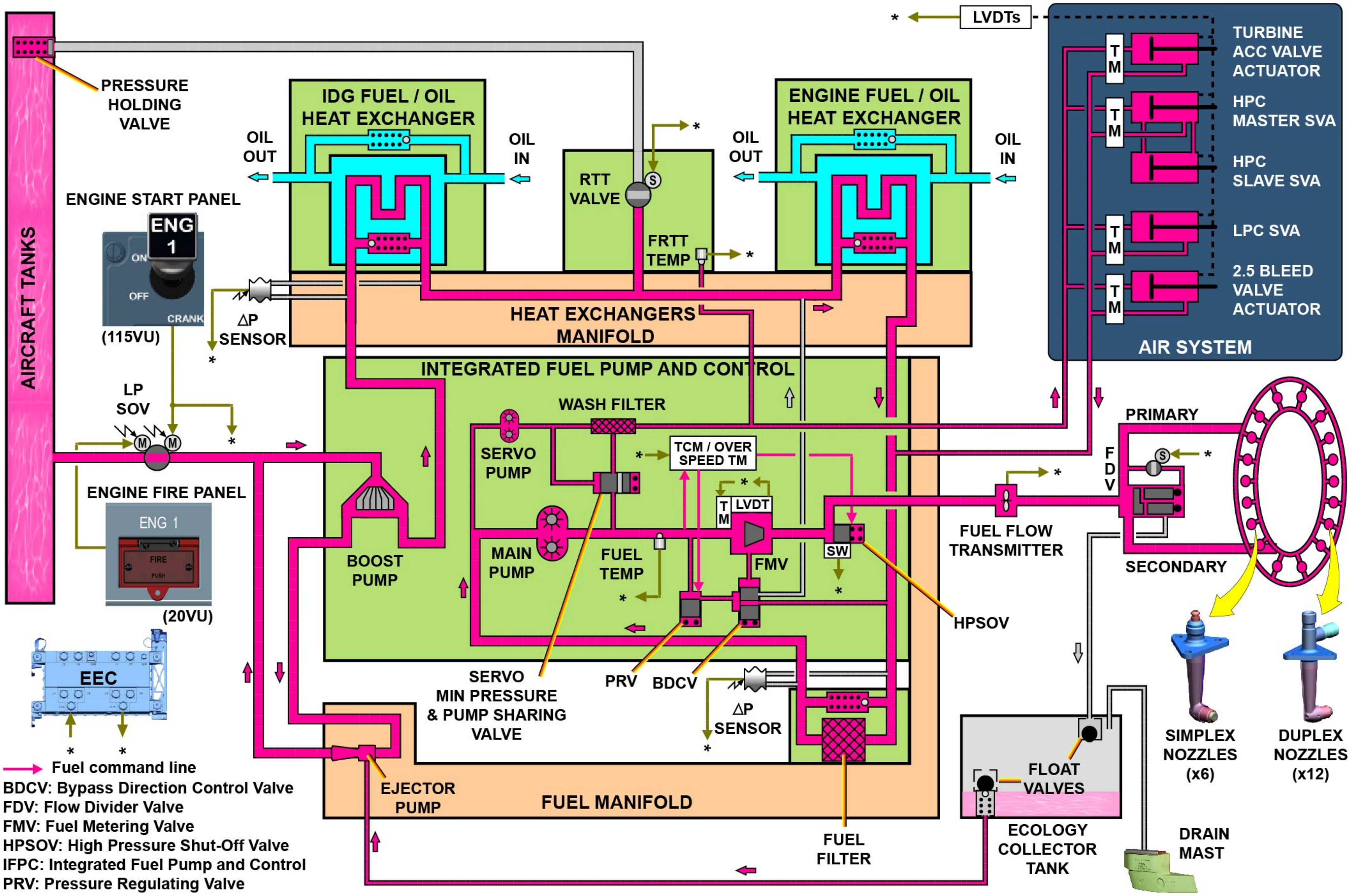
STARTING - INITIATION

ENGINE FUEL SYSTEM D/O (3)

STARTING (continued)

ACCELERATION

As the pumps rotation speed increases with the engine acceleration, the fuel pressure also increases. The FMV opens more and as a consequence the fuel pressure pushes the BDCV out of its rest position to direct the excess fuel flow to the fuel filter.
The FDV also opens more and evenly divides metered fuel flow between the primary and secondary fuel nozzles.
In parallel, the fuel pressure from the servo pump increases and pushes the Servo Minimum Pressure and Pump Sharing Valve, segregating the burn flow from the servo fuel.



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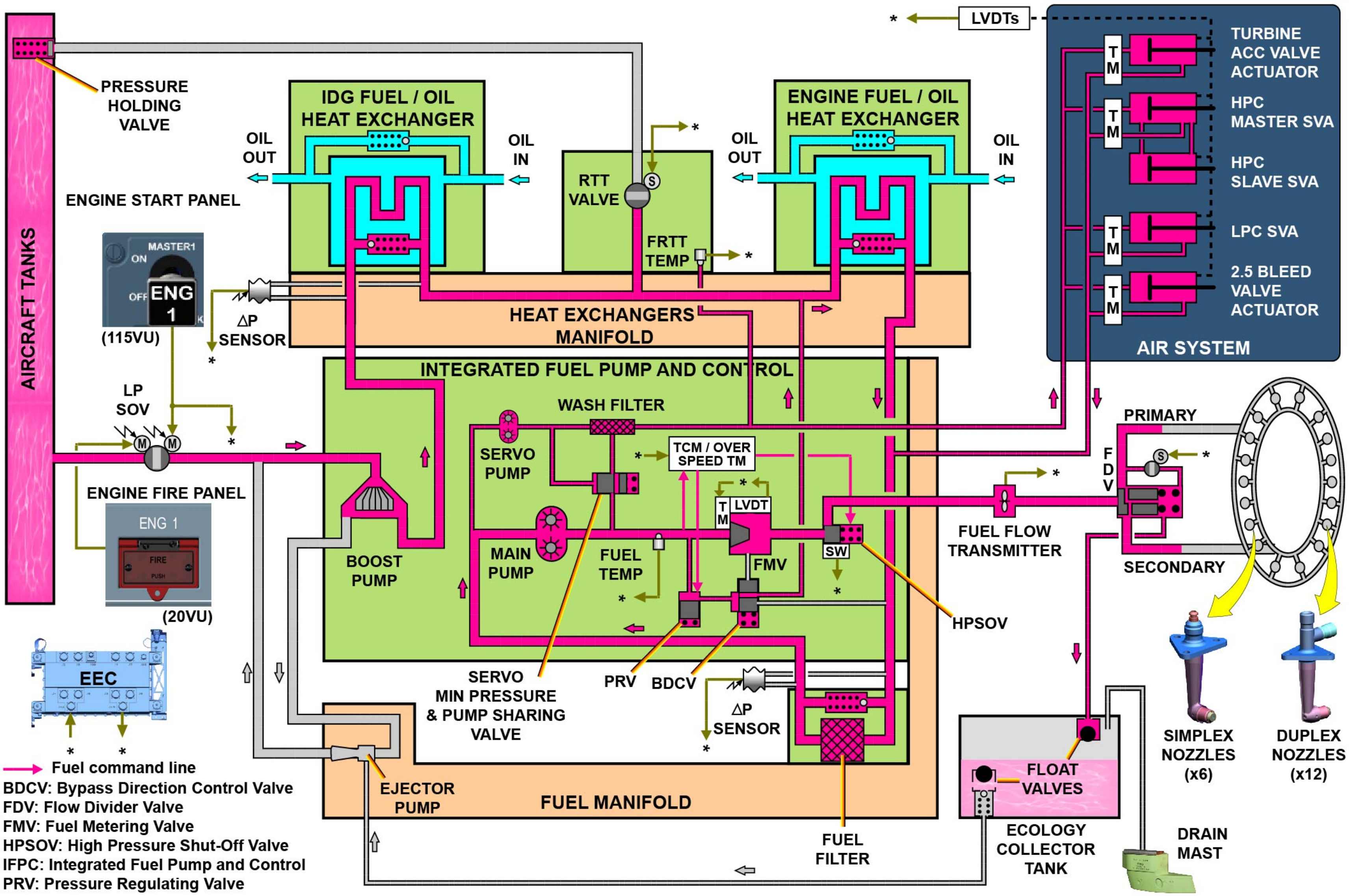
STARTING - ACCELERATION

ENGINE FUEL SYSTEM D/O (3)

SHUTDOWN

NORMAL SHUTDOWN

During a normal engine shutdown, the Master Lever controls the LPSOV to close and sends a shutdown signal to the EEC.
As a consequence, the EEC controls the TCM/overspeed TM that directs fuel pressure to the back side of the HPSOV to close it and stop the fuel flow to the engine. In the same time, the PRV is controlled fully open to bypass the main pump fuel flow away from the FMV to the FOHE.
In turn when the related fuel pressure drops, the FDV closes to let the remaining fuel in the nozzle manifolds to drain in the ecology drain tank, and the Servo Minimum Pressure and Pump Sharing Valve reopens.
After the HPSOV is confirmed closed by the proximity switches, the EEC tests the FMV via its TM then closes it.



SHUTDOWN - NORMAL SHUTDOWN

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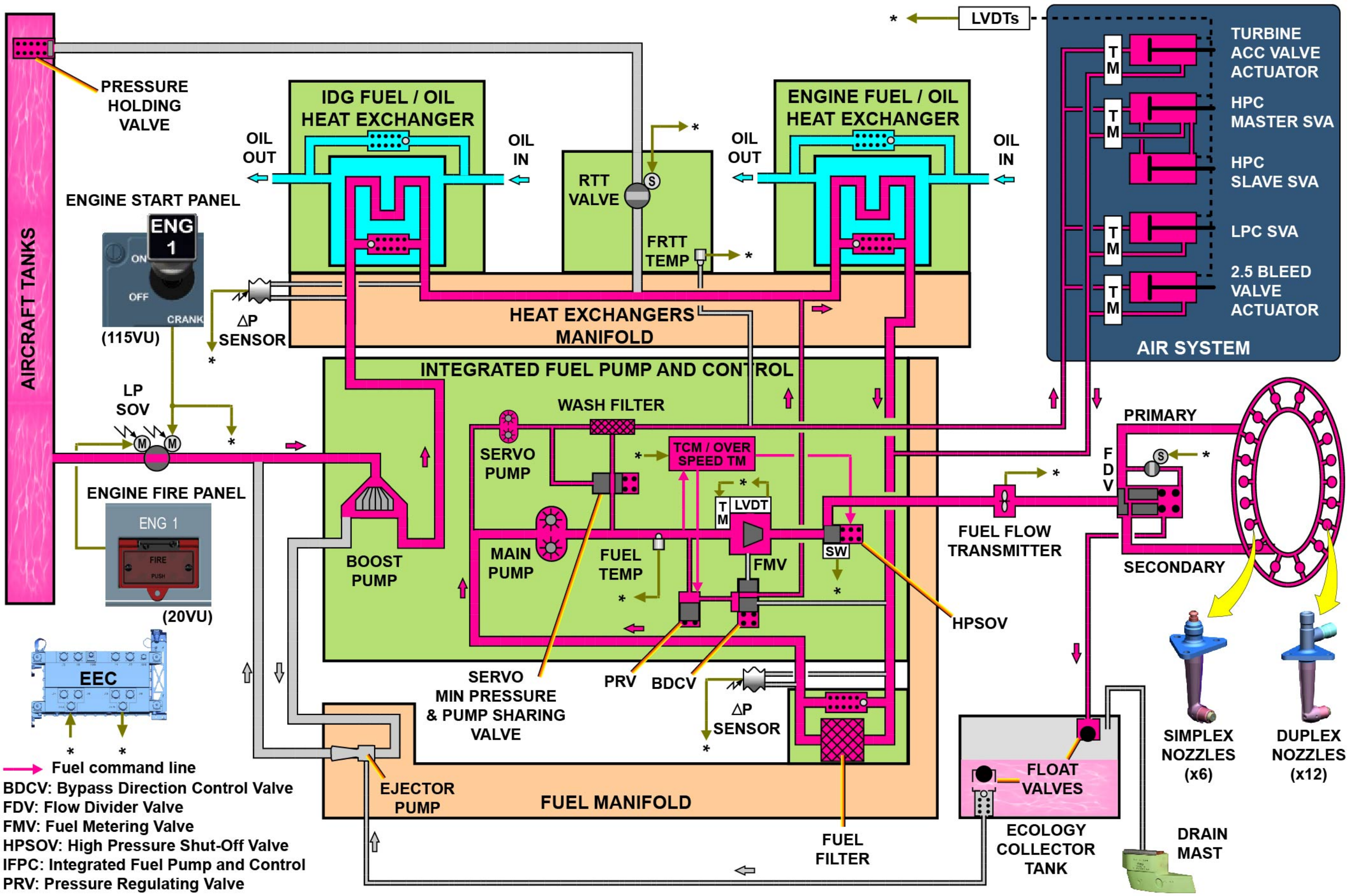
ENGINE FUEL SYSTEM D/O (3)

SHUTDOWN (continued)

ABNORMAL SHUTDOWN

The abnormal shutdown is initiated in case of an overspeed (N1 or N2), shaft shear (fan, LP or HP) or Thrust Control Malfunction (TCM) event detected on ground.
In such case, the TCM/overspeed TM directs fuel pressure to the back side of the HPSOV and of the PRV. This causes the PRV to open and stop fuel flow to the FMV, allowing rapid closure of the HPSOV and rapid engine shutdown.
Fuel flow through the PRV is directed to the BDCV and then to the engine FOHE.
This shutoff method is independent from the FMV control.



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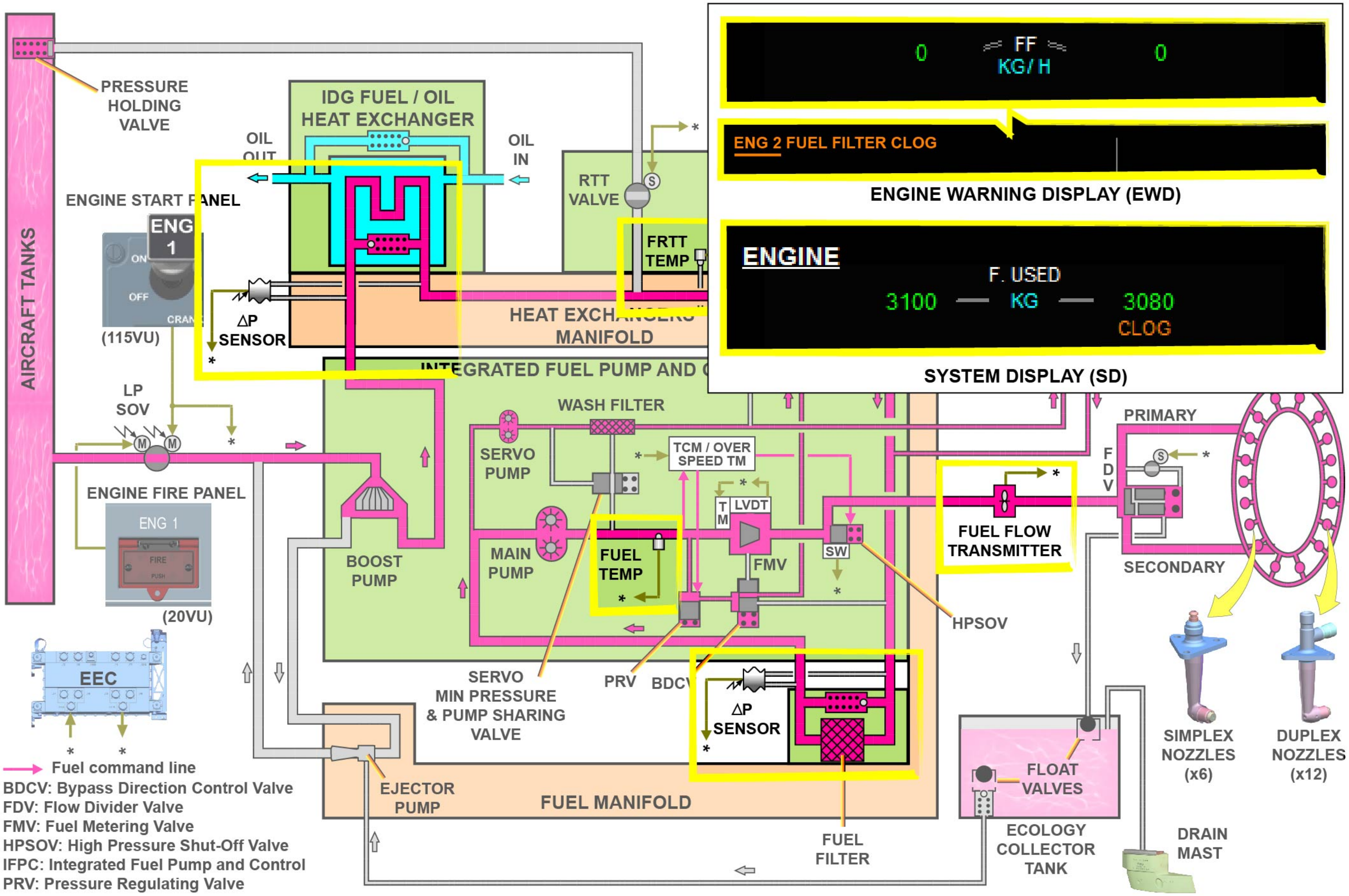
SHUTDOWN - ABNORMAL SHUTDOWN

ENGINE FUEL SYSTEM D/O (3)

FUEL INDICATING

The engine fuel indicating monitors the system condition and provides the system status to the cockpit displays.
The fuel flow transmitter sends signals to the EEC which enables the calculation of the fuel flow to the combustor.
The fuel flow is a primary engine parameter and is displayed on the EWD permanently. The EEC also sends this data for the fuel used computation and display on the System Display (SD).
The Fuel Filter Differential Pressure (FFDP) sensor measures the differential pressure across the fuel filter.
This helps to detect if the filter is partially or totally clogged.
According to the received value, the EEC will generate various warnings on the EWD: ENG X FUEL FILTER DEGRAD or ENG X FUEL FILTER CLOG or ENG X FUEL SENSOR FAULT and on the SD: CLOG.
The IDG Fuel-Oil Heat Exchanger (FOHE) differential pressure sensor is used to sense the differential pressure on the fuel side of the FOHE and send a signal to the EEC in case of clogging detection. According to the status, the EEC will generate various warnings on the EWD: ENG X HEAT EXCHANGR CLOG or ENG X FUEL SENSOR FAULT.
For monitoring and Thermal Management System control by the EEC, the fuel temperature is sensed by two dual channel temperature sensors.
The fuel temperature sensor is used for the control of the heat exchangers (Fuel/Oil Heat Exchanger Bypass Valve (FOHEBV)) and BDCV.
The Fuel Return To Tank (FRTT) temperature sensor is used for the RTTV control.
The engine fuel temperature is not directly displayed in the cockpit but, according to the status, the EEC will generate various warnings on the EWD: ENG X HOT FUEL or ENG X FUEL HEAT SYS or ENG X HEAT SYS DEGRADED or ENG X HEAT SYS FAULT.



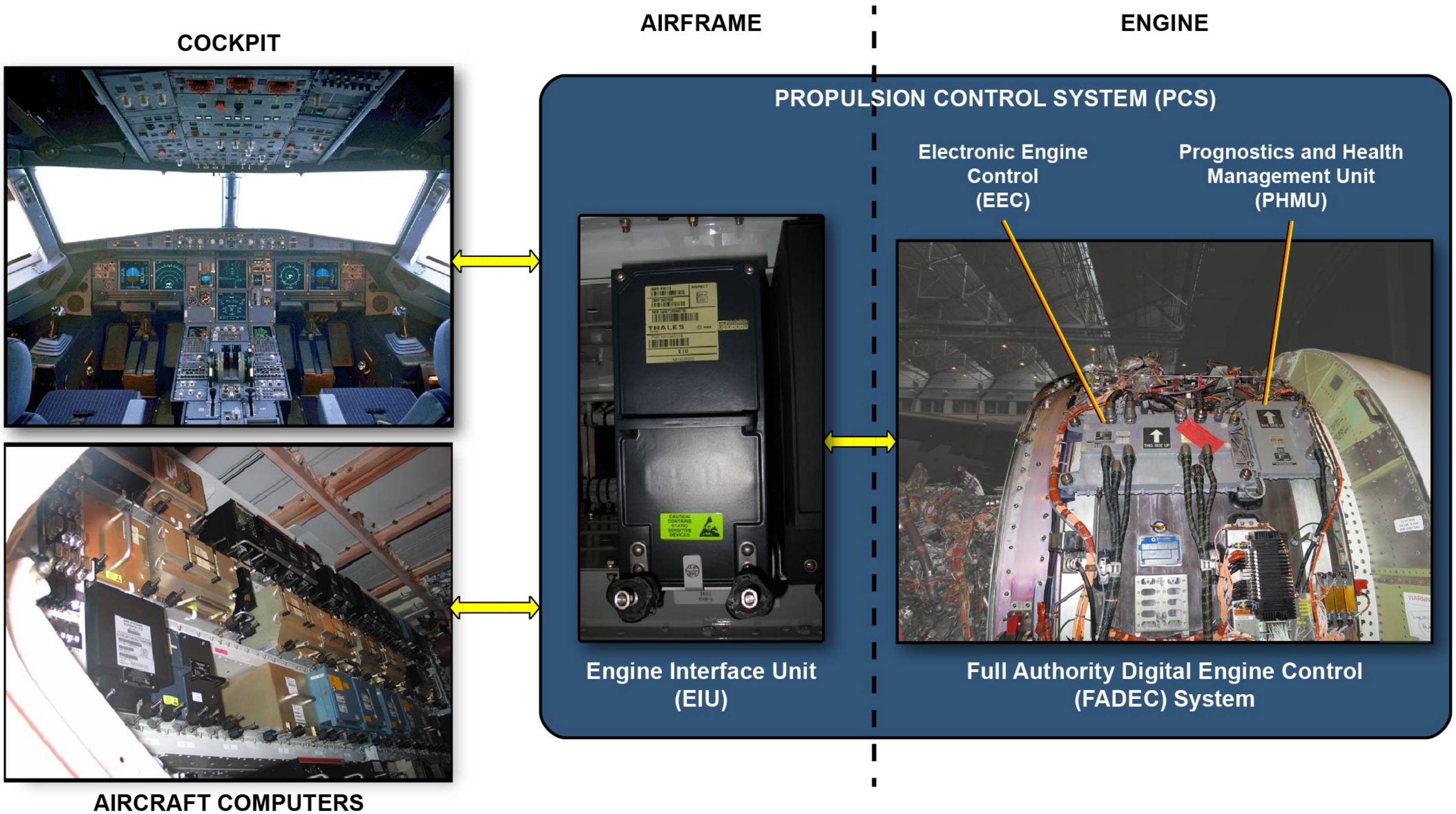
FUEL INDICATING

UJ515241 - U08T0MEP - UM73D1PW1100G05

PROPULSION CONTROL SYSTEM (PCS) PRINCIPLE (3)

GENERAL

The Propulsion Control System (PCS) consists in Engine Interface Unit (EIU) and FADEC System which includes Electronic Engine Control (EEC) and Prognostics and Health Management Unit (PHMU).
Each EIU is dedicated to an engine. EIU 1 and 2 are located in the aircraft avionics bay 80VU.
The EEC and PHMU are attached to the engine fan case assembly at 2:30.
Both EEC & PHMU are vibration-isolated units, which are cooled by natural convection.



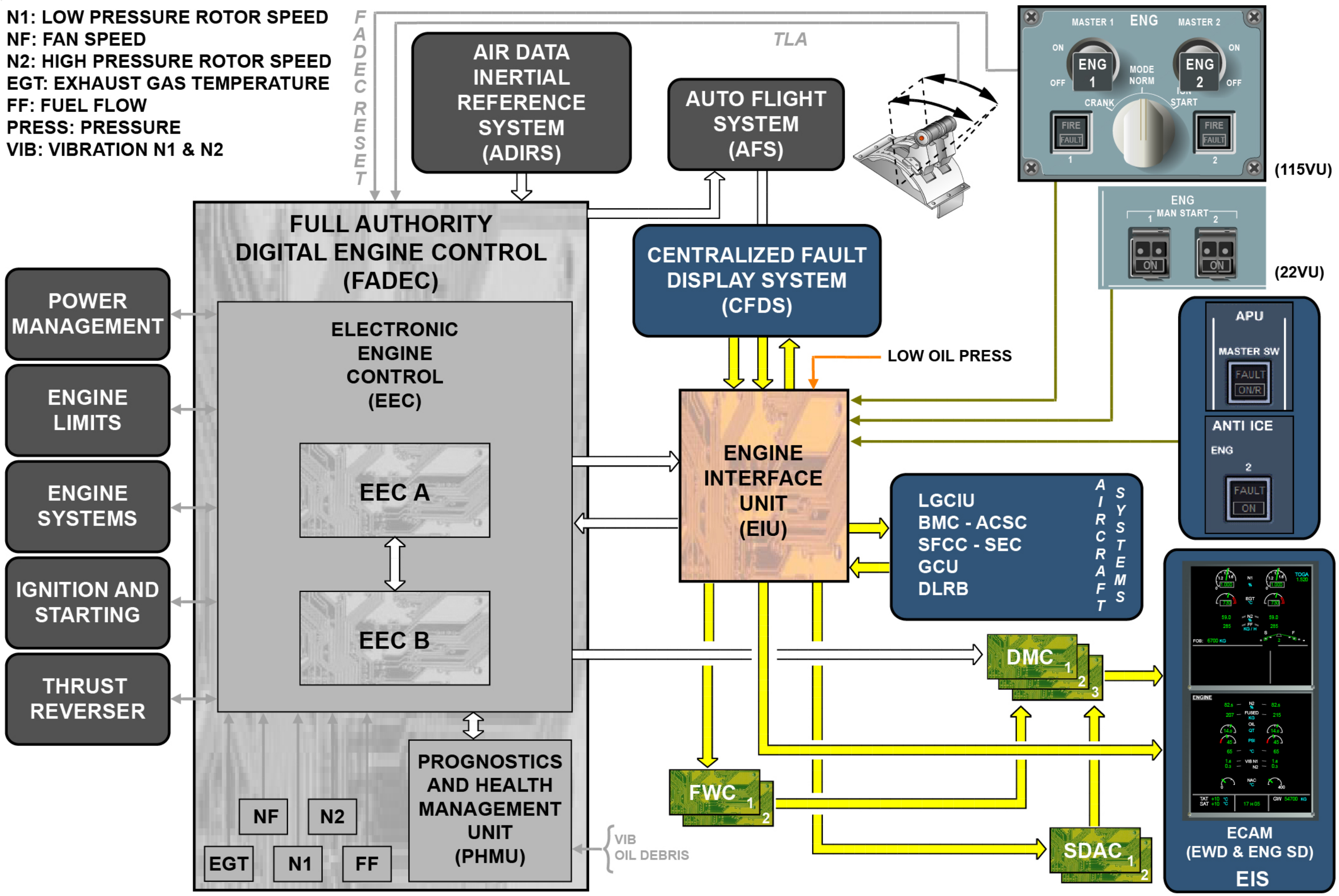
UJ515241 - U08T0MEP - UM73D2PW1100G05

GENERAL

PROPULSION CONTROL SYSTEM (PCS) PRINCIPLE (3)

ENGINE INTERFACE UNIT

Each EIU is an interface concentrator between the airframe and the corresponding EEC on the engine.
It ensures the segregation of the 2 engines and aircraft electrical power supply to the FADEC.
It concentrates data from or to the cockpit panels and displays.
It gives logics and information to or from other aircraft systems as Flight/Ground from Landing Gear Control and Interface Unit (LGCIU).

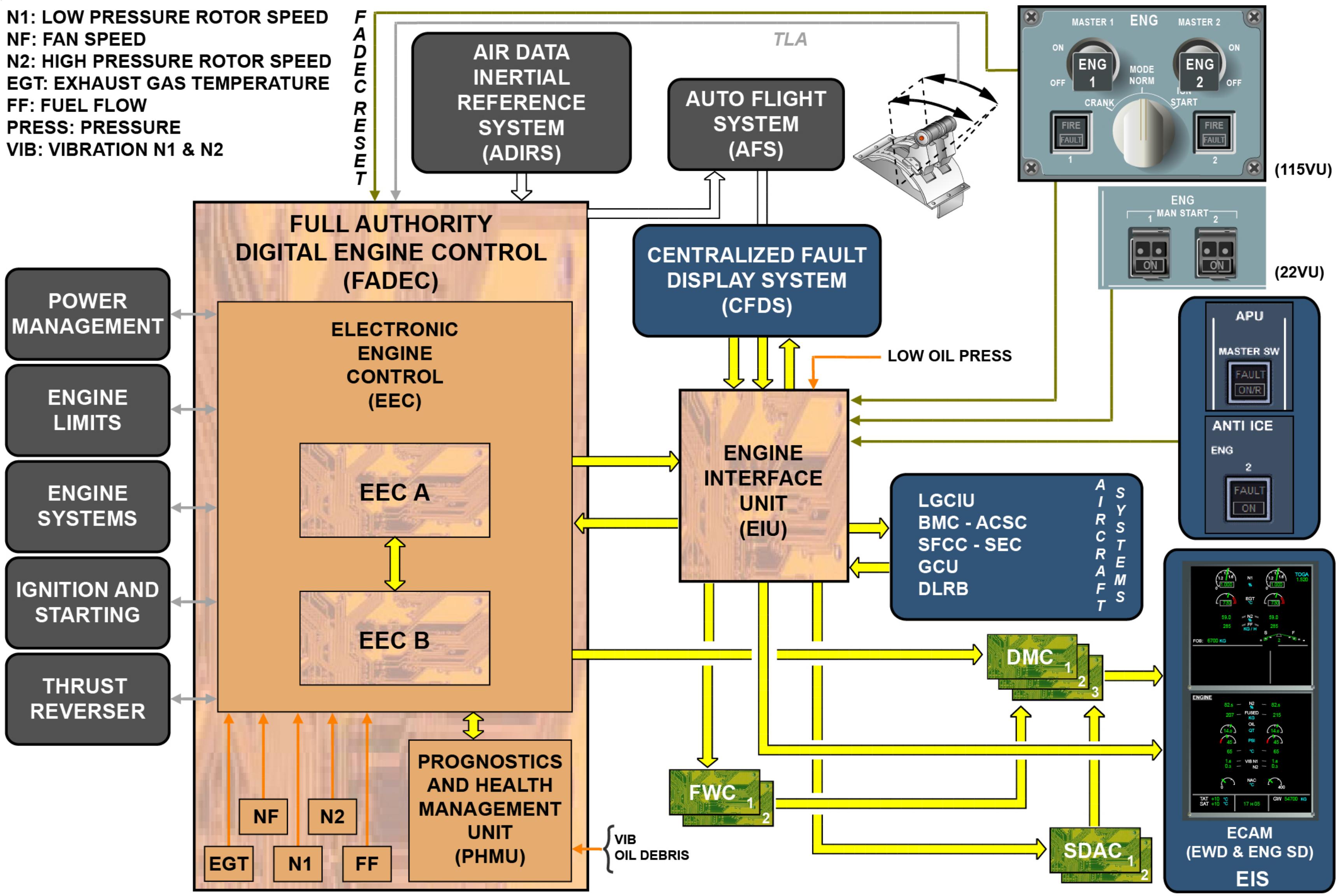


ENGINE INTERFACE UNIT

PROPULSION CONTROL SYSTEM (PCS) PRINCIPLE (3)

FADEC

The FADEC consists in a dual channel EEC with crosstalk and failure detection, a PHMU and sensors used for control and monitoring.
The FADEC system manages the engine thrust and optimizes the performance.
The EEC interfaces with most of the A/C systems through the EIU.
The FADEC controls the engine parameters displayed in the cockpit.
The primary parameters (N1, N2, Exhaust Gas Temperature (EGT) and Fuel Flow (FF)) are sent by the EEC to the ECAM through Display Management Computers (DMCs).
The engine system page shows secondary parameters: oil quantity, pressure and temperature.
The vibration figures are communicated by the PHMU to the EEC.
The Flight Warning System (FWS) will gather necessary information directly from EEC, EIU, System Data Acquisition Concentrator (SDAC) and generates associated messages on Engine/Warning Display (EWD).



FADEC

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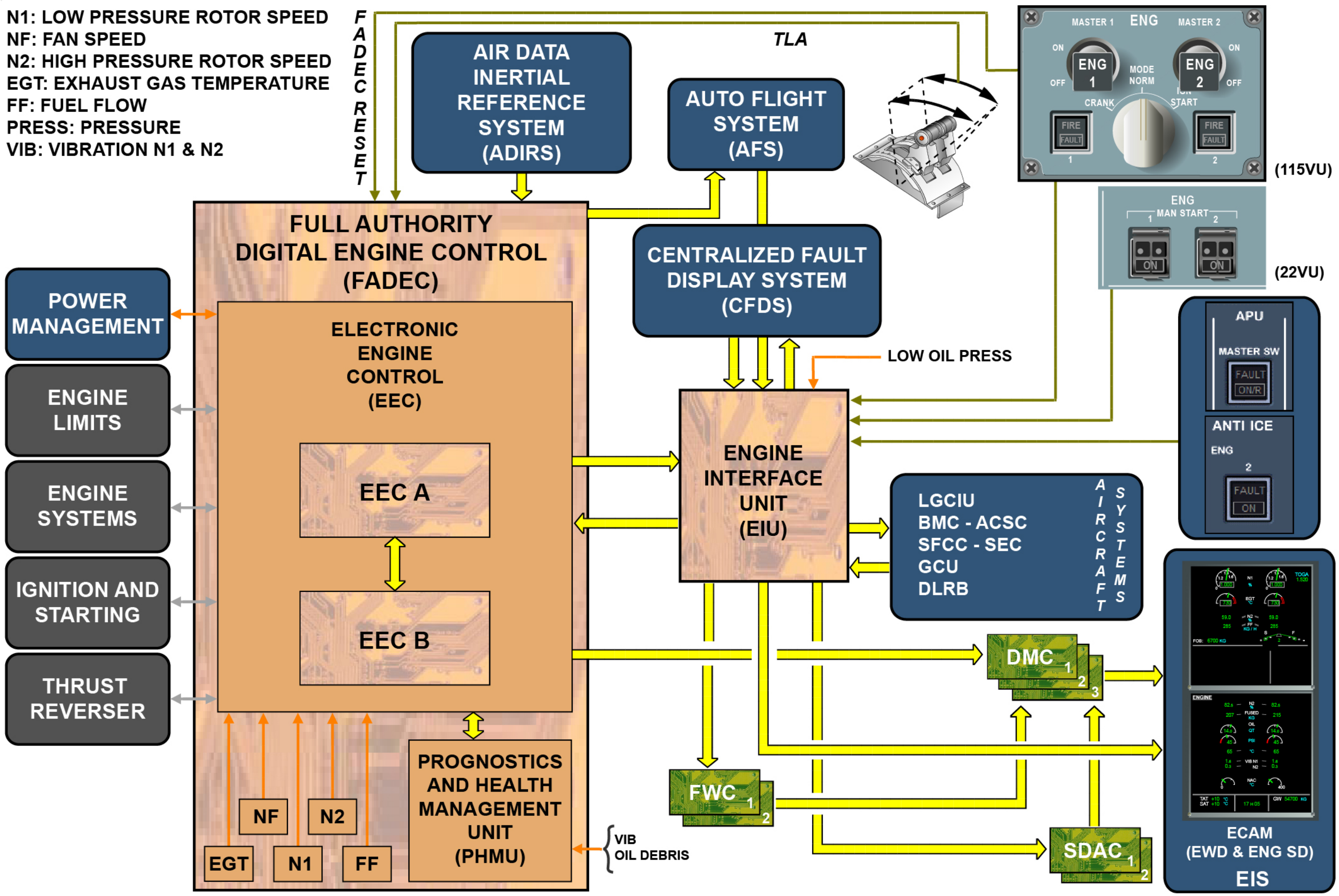
PROPULSION CONTROL SYSTEM (PCS) PRINCIPLE (3)

POWER MANAGEMENT

The FADEC provides automatic engine thrust control and thrust parameter limit computation.
The EEC uses air data parameters from Air Data/Inertial Reference System (ADIRS) for rating calculations.
The FADEC manages power according to two thrust modes:
- manual mode depending on Throttle Lever Angle (TLA),
- autothrust mode depending on autothrust function generated by the Auto Flight System (AFS).

The FADEC also provides two idle mode selections: minimum idle and approach idle.
If the aircraft is on ground and extend the slats the engine will stay at minimum idle but in flight it will go to approach idle. The idle can also be modulated up to approach idle depending on: Air conditioning demand, wing anti-ice demand, engine anti-ice demand and oil temperature (for Integrated Drive Generator (IDG) cooling).

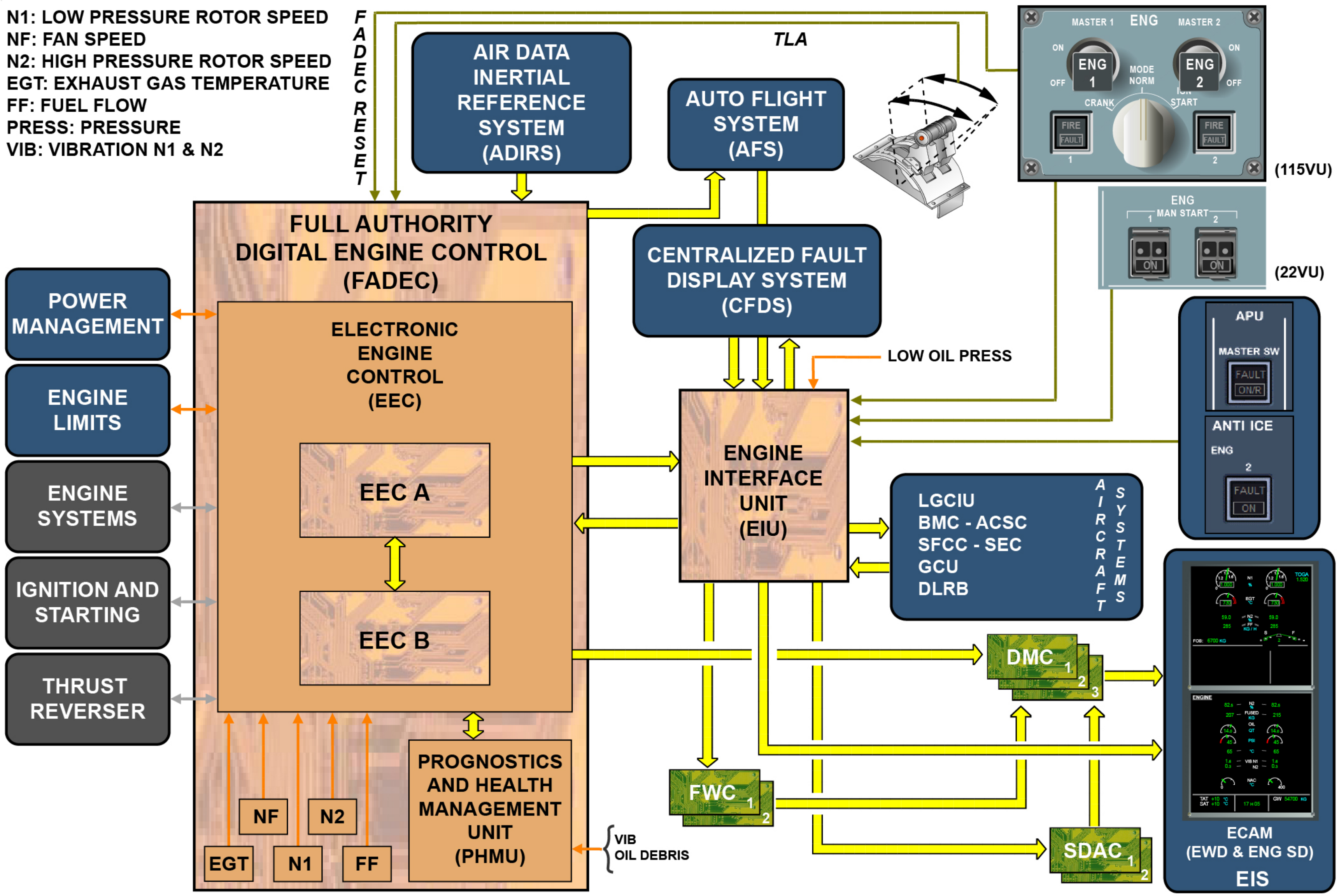


POWER MANAGEMENT

PROPULSION CONTROL SYSTEM (PCS) PRINCIPLE (3)

ENGINE LIMIT PROTECTION

The FADEC ensures engine integrity protection. It provides overspeed protection for N1 and N2 or rotor shaft shear by driving to close the Thrust Control Malfunction (TCM)/Overspeed torque motor in the Integrated Fuel Pump and Control (IFPC).
Shaft shear detection logic is only active at high power settings.
It ensures overheat protection by monitoring EGT, nacelle and EEC temperature.

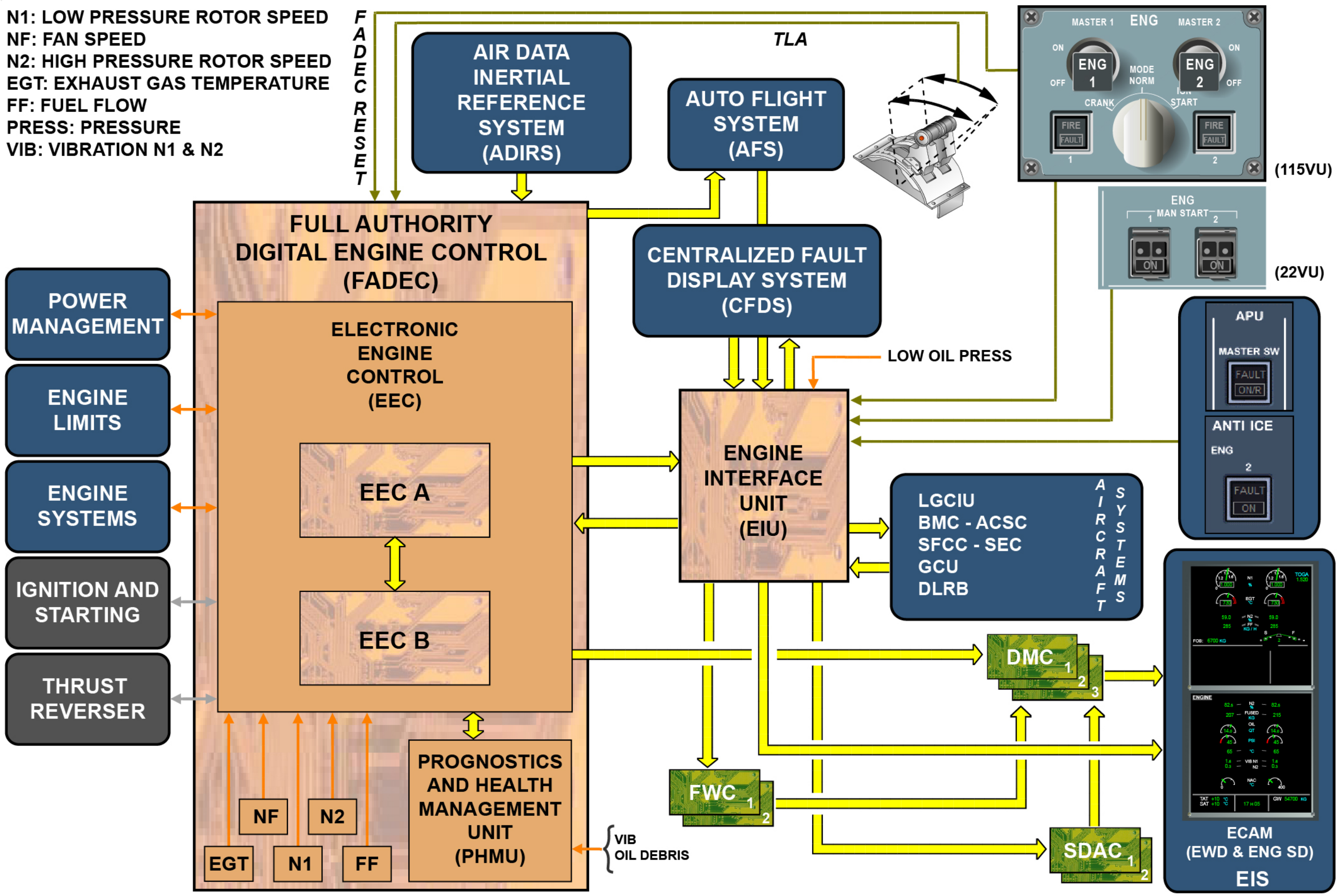


ENGINE LIMIT PROTECTION

PROPULSION CONTROL SYSTEM (PCS) PRINCIPLE (3)

ENGINE SYSTEM CONTROL

The FADEC provides optimal engine operation by controlling:
- combustor metering valve and fuel flow,
- compressor airflow and turbine case cooling,
- thermal management (oil cooling, fuel heating),
- control and monitoring sensors,
- BITE (fault detection, isolation, annunciation and transmission to the aircraft),
- nacelle anti-ice.

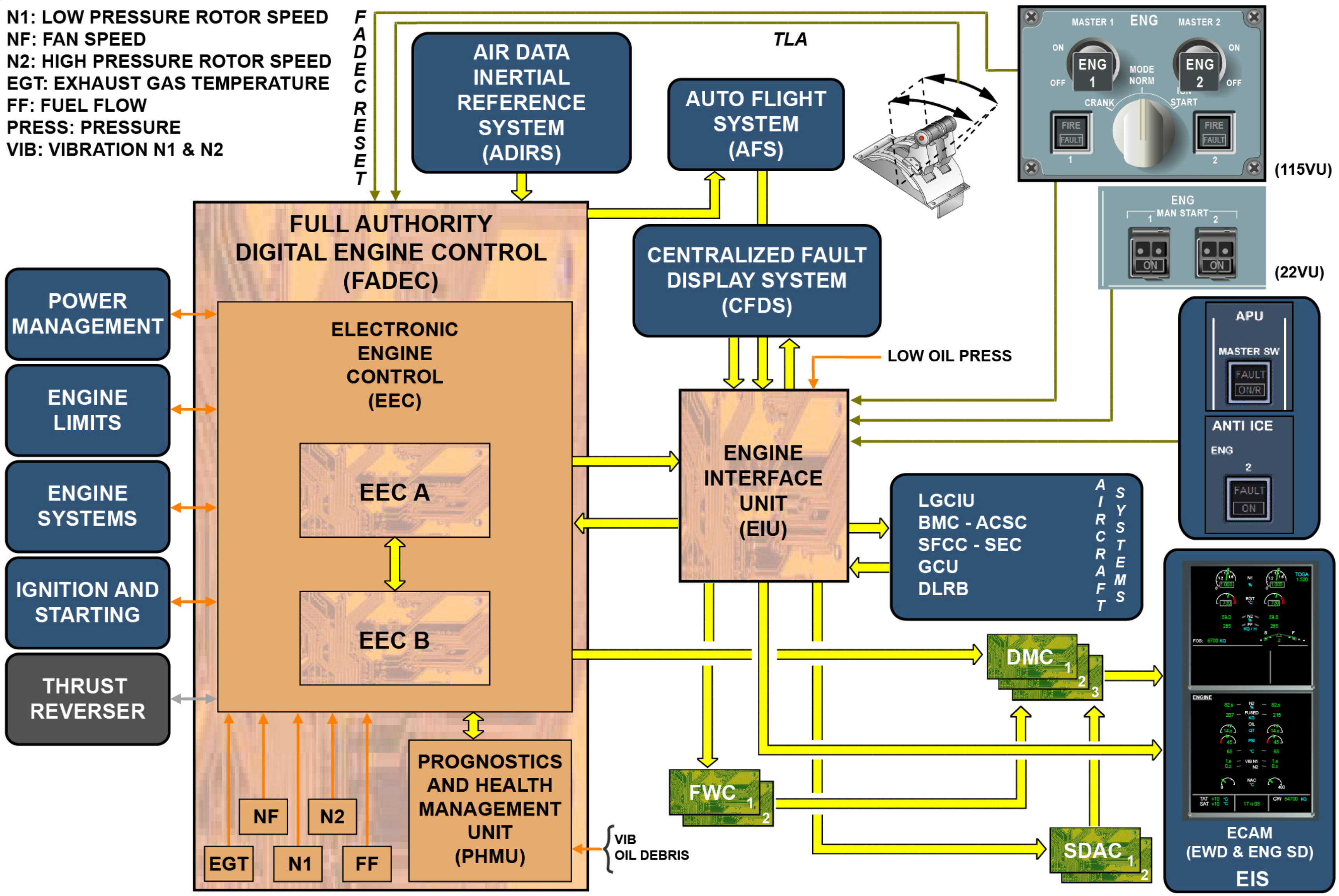


ENGINE SYSTEM CONTROL

PROPULSION CONTROL SYSTEM (PCS) PRINCIPLE (3)

STARTING AND IGNITION CONTROL

The FADEC controls the engine start sequence in automatic or manual mode when initiated from the control panels.
It monitors N1, N2, EGT and oil parameters and then can abort or recycle an engine start.

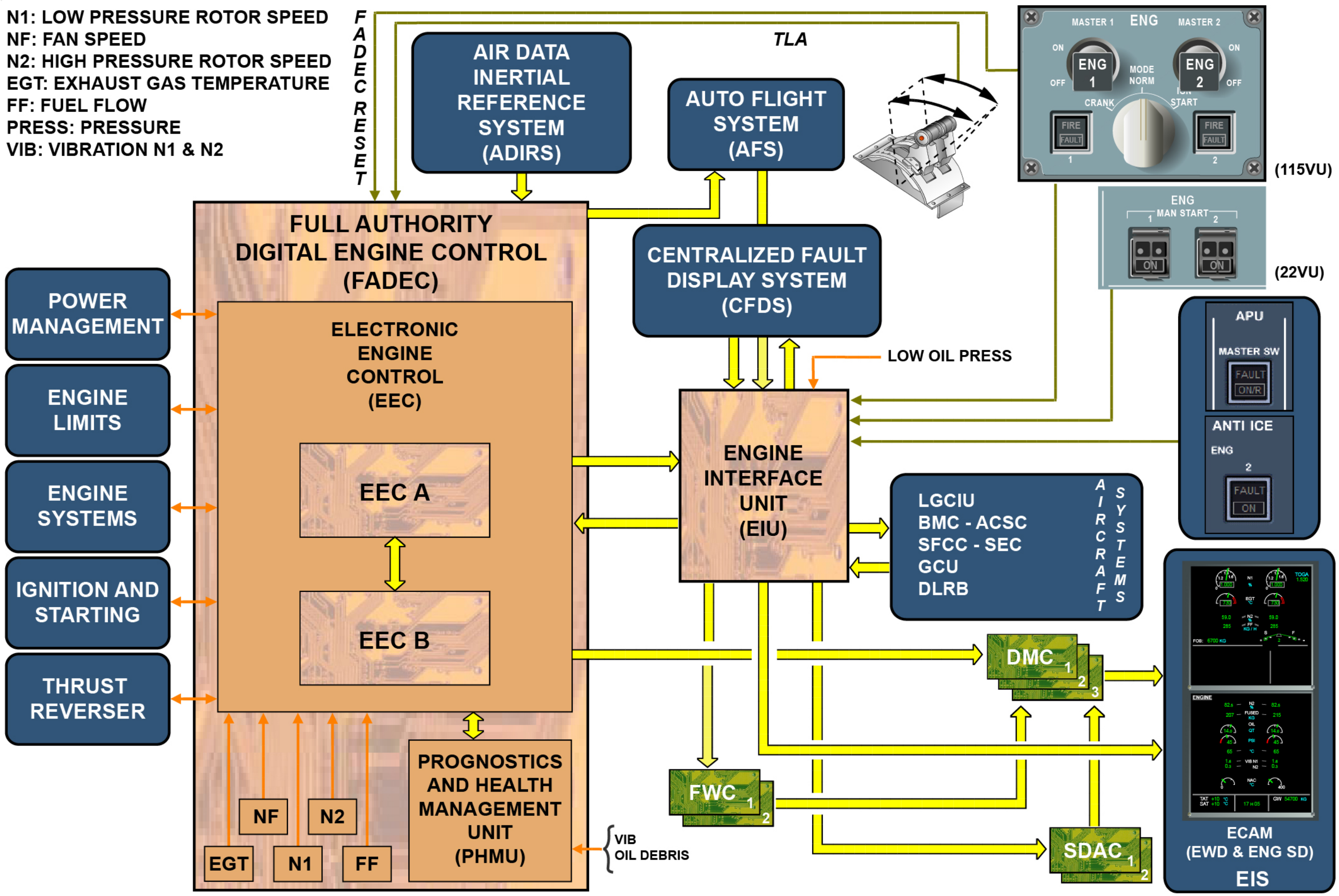


STARTING AND IGNITION CONTROL

PROPULSION CONTROL SYSTEM (PCS) PRINCIPLE (3)

THRUST REVERSER

The FADEC supervises the thrust reverser operation.



THRUST REVERSER

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FADEC ARCHITECTURE (3)

ARCHITECTURE

The FADEC consists in the Electronic Engine Control (EEC), the Prognostic and Health Monitoring Unit (PHMU) and peripherals (sensors and output drivers).

EEC

The EEC is a microprocessor controlled digital unit with two independent control channels identified as channel A and B.
Each channel has its own processors, power supply, program memory, selected input sensors and output drivers.
In addition to input/output redundancy (for comparison and backup), data is sent internally between the two channels by a crosstalk data link.
Each channel receives inputs from the A/C and FADEC system sources. Thus, each channel can monitor and control the operation of the engine and transmit engine data to the A/C and to engine subsystem duplicated controls (torque motors and solenoids).
EEC channels A and B are housed in one assembly but are physically divided by a two-piece modular design. Each channel module has one printed circuit board module, the input/output interconnect modules and one pressure sensor.
Five electrical connectors are used in each channel module to connect wiring from the engine, aircraft and nacelle.
The EEC also has a connector to test the unit and a connector for the Data Storage Unit (DSU).

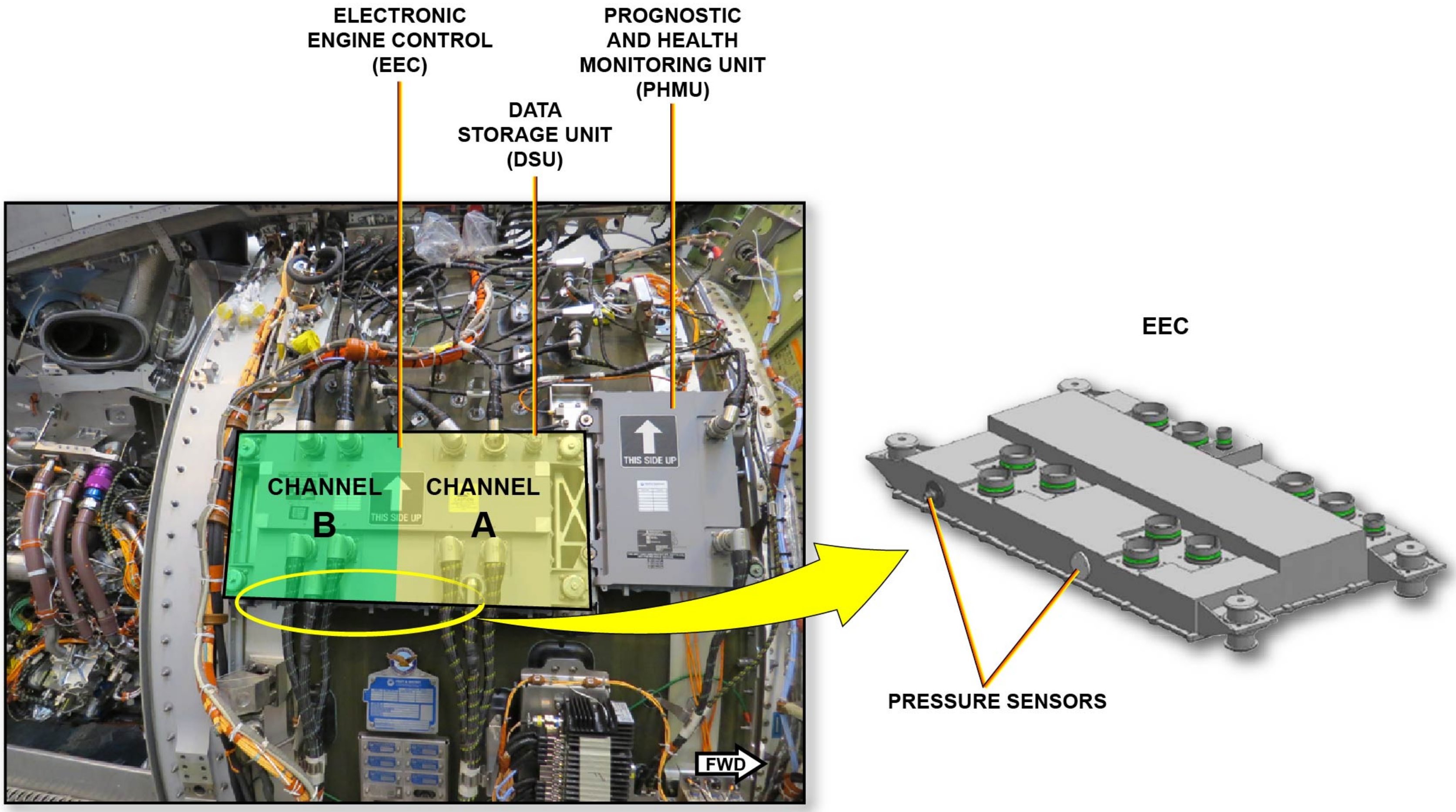
DSU

The DSU is a data memory plug attached to the engine case bracket by a lanyard and connected on the EEC channel A for engine identification and rating, engine trim data storage and detected failures storage.

PHMU

The PHMU is a single channel component with internal software that performs the following engine health monitoring functions:
- Vibration analysis,
- Engine trim balance solution computation,
- Oil Debris Monitoring (ODM),
- Auxiliary Oil Pressure (AOP) signal conversion.

It uses data provided by several engine sensors and by the EEC and sends back the computed data to the EEC through CAN buses. Two connectors are used for the data exchange.



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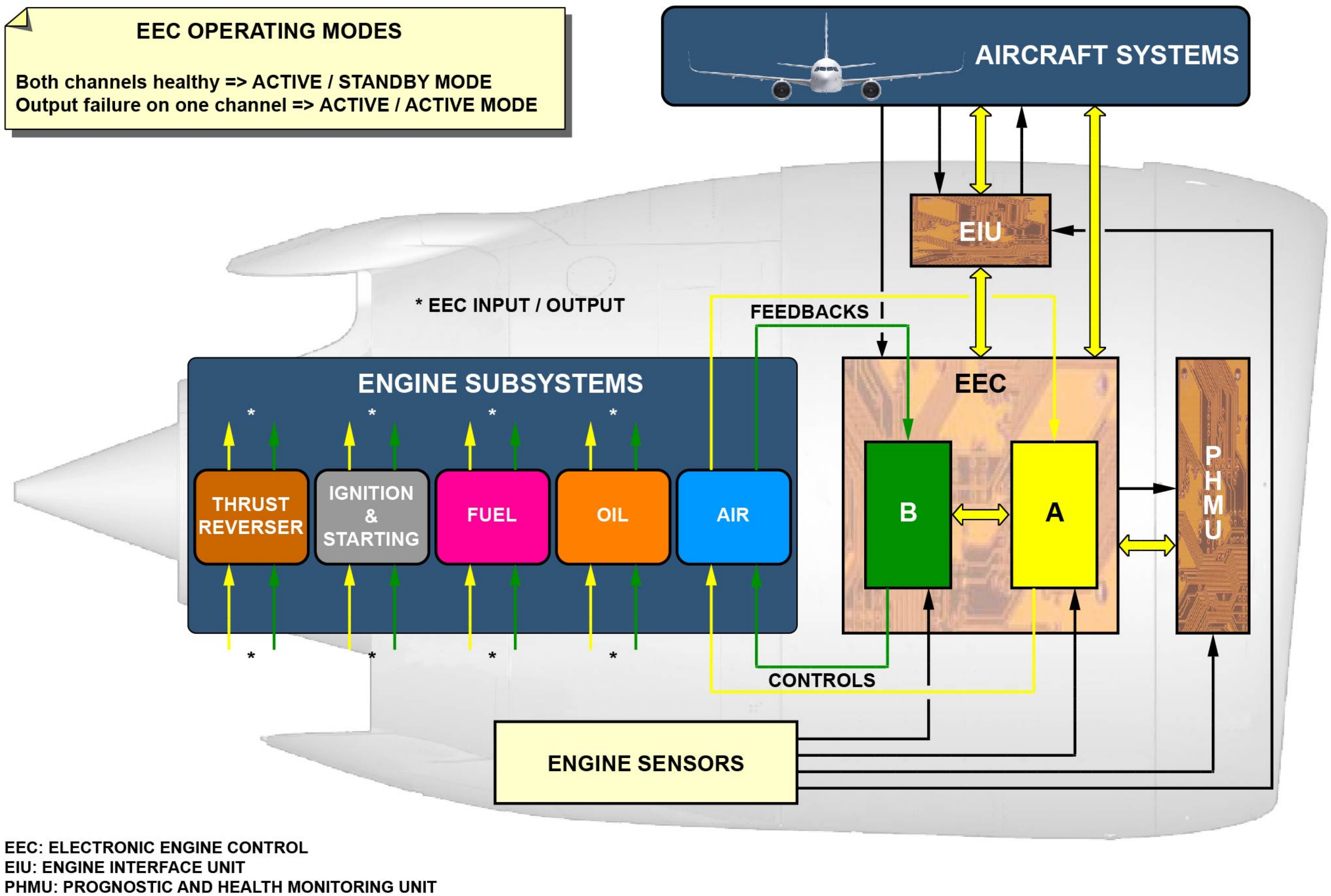
ARCHITECTURE - EEC ... PHMU

FADEC ARCHITECTURE (3)

PROCESS

Most of the FADEC operations are based on the same principle, they respond to a demand from the A/C or from the EEC internal schedules, and they take into account input parameters from the A/C and from the engine sensors. Most of the sensors and output drivers are duplicated for redundancy and segregated to each EEC channel.
For a control loop, one EEC channel elaborates a single command signal sent to an engine subsystem control and it makes sure that its command has been followed by monitoring the dual feedback from this engine subsystem. The EEC also continuously performs integrity test of its control circuits.
When fully operational, the EEC starts and operates in an Active-Standby mode. Under this control scheme, only one channel of the EEC has full authority over all engine functions and is identified as the preferred channel. The preferred channel is alternated upon every engine shutdown for the next engine start.
If a feedback fault is detected in the preferred channel, the data is retrieved from the standby channel via the crosstalk data link.
If an output driver fault is detected, the EEC switches from Active-Standby mode to Active-Active mode. This allows either channel to control any of the output drivers independently, regardless of which channel is the preferred channel.
This control mode allows both channels to be engaged simultaneously and to manage different engine functions, providing an effective fault accommodation strategy. If the crosstalk data link is lost, each channel maintains its current controls prior the failure.
If the engine subsystem control loop is no more possible (by any channel), the subsystem control is set to its failsafe position.



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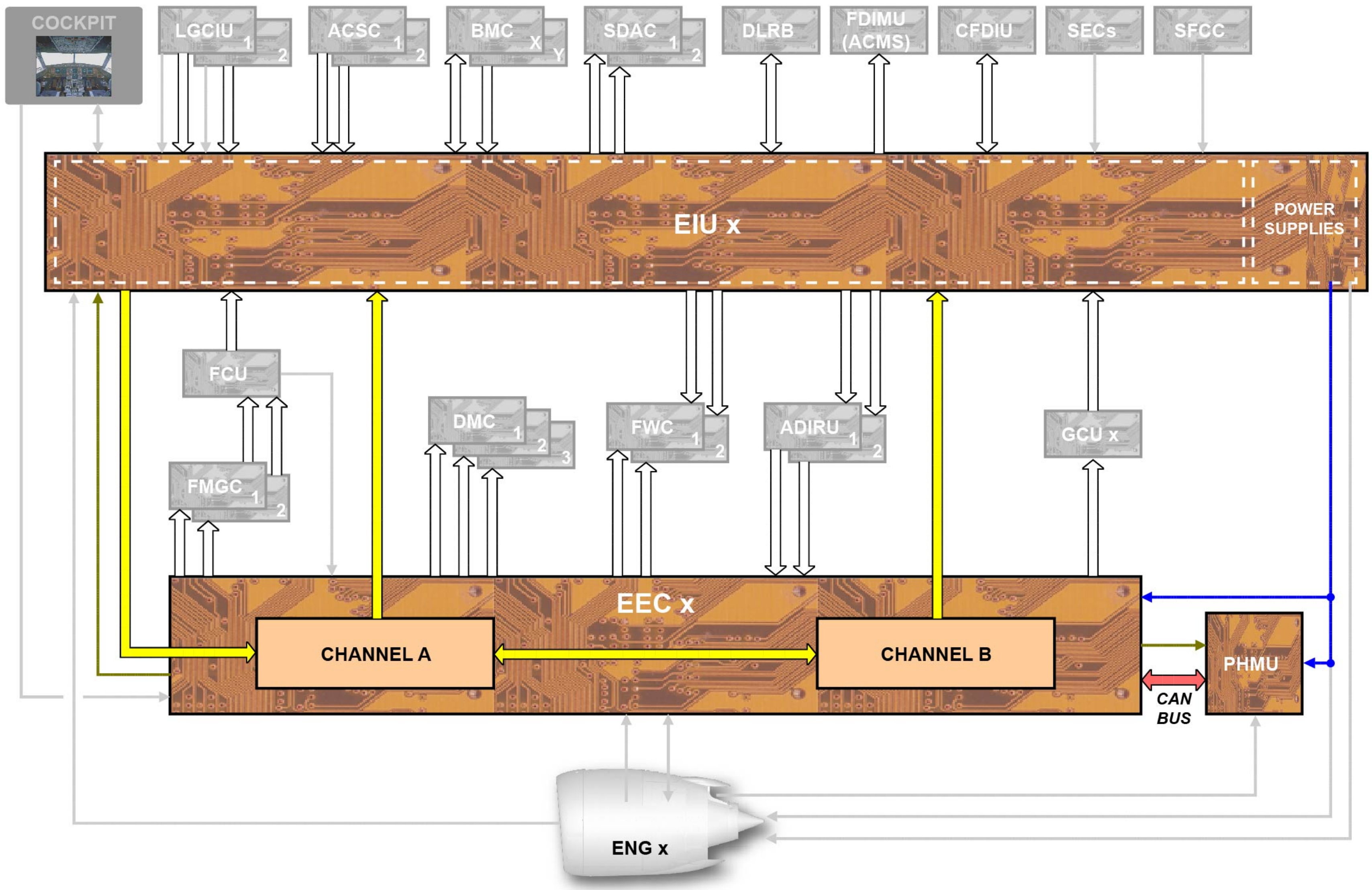
PROCESS

FADEC INTERFACES (3)

GENERAL

In order to provide a full range of engine control and monitoring, the Propulsion Control System (PCS) exchanges data within its own computers (Engine Interface Unit (EIU), Electronic Engine Control (EEC), Prognostic and Health Monitoring Unit (PHMU)) and with the other aircraft systems computers. The EIU is the main interface with the aircraft systems.
Inputs or outputs are transmitted on a digital, analog or discrete format.



GENERAL

UJ515241 - U08T0MEP - UM73D4PW1100G05

FADEC INTERFACES (3)

PCS INTERFACES

The EIU performs the following bus transfer.

EIU digital inputs from:

GCU #: for idle modulation based on Integrated Drive Generator (IDG) load.
DLRB: for EIU dataloading.
ACSC 1/2: for bleed decrement computation.
CFDIU: for BITE purposes (Normal Mode and Menu Mode).
BMC 1/2: for bleed computation.
LGCIU 1/2: for flight/ground status computation.
FCU: for Autothrust function and Thrust Control Malfunction (TCM) protection in flare.

EIU digital outputs to:

ADIRU 1/2: for air data correction.
CFDIU: for BITE purposes (Normal Mode and Menu Mode).
DLRB: for EIU dataloading.
SDAC 1/2: for engine parameters acquisition.
FDIMU (ACMS): for condition monitoring and troubleshooting purpose.
BMC #: for bleed computation
FWC 1/2: for warnings display.
The EIU performs the following discrete exchange.

EIU discrete inputs from:

From cockpit controls:
- Master lever ON/OFF
- Throttle position (switches): for thrust reverser operation.
- Rotary selector Ignition/Auto/Crank
- Wing De-Ice P/B OFF: for bleed decrement computation.
- Nacelle Anti-Ice P/B ON/OFF: for Nacelle Anti-Ice (NAI) control and bleed decrement computation.
- Fire handle ON: for engine isolation.
- Manual Engine Start P/B ON
- FADEC Ground Power ON
- Bump ON/OFF
- APU Master Switch ON/OFF: for bleed decrement computation.
From LGCIUs:
- LH Landing Gear compressed: for flight/ground status computation.
- RH Landing Gear compressed: for flight/ground status computation.
- Nose Landing Gear (NLG) compressed: for flight/ground status computation.
From SECs:
- Ground Spoiler OUT
- TLA < -3 deg
From SFCC:
- Flaps and Slats lever retracted
From engine:
- FRTTV Selected OFF (EEC)
- Low Oil Pressure sensor: for OIL LO PRES warning.
- Engine position and type
- Latch Door Monitoring Proximity Switches.

EIU discrete outputs:

Fuel HPSOV Closed
N2 Not Below Idle
TLA in Take Off Position
Start Valve Closure
APU Boost Command
Master Lever Fault Light
Oil Low pressure and Ground
NAI P/B Fault Light
Latch Door Monitoring Proximity Switches
The EIU provides the following power supplies.

EIU power supply outputs to:

PHMU (28V DC).

Hydraulic pump depressurization solenoid (28V DC).
EEC channels (28V DC).
Igniters (115V AC).
Thrust reverser Valves (28V DC for ICV & DCV).
Unless specified differently, signals are dual (from/to both EEC channels).
The EEC performs the following bus transfer.

EEC digital inputs from:

EIU # (channel A): for aircraft data exchange.
ADIRU 1/2: for engine control (alt, TAT, PT, CAS, Mn).
PHMU: for vibration monitoring and trim balancing.

EEC digital outputs to:

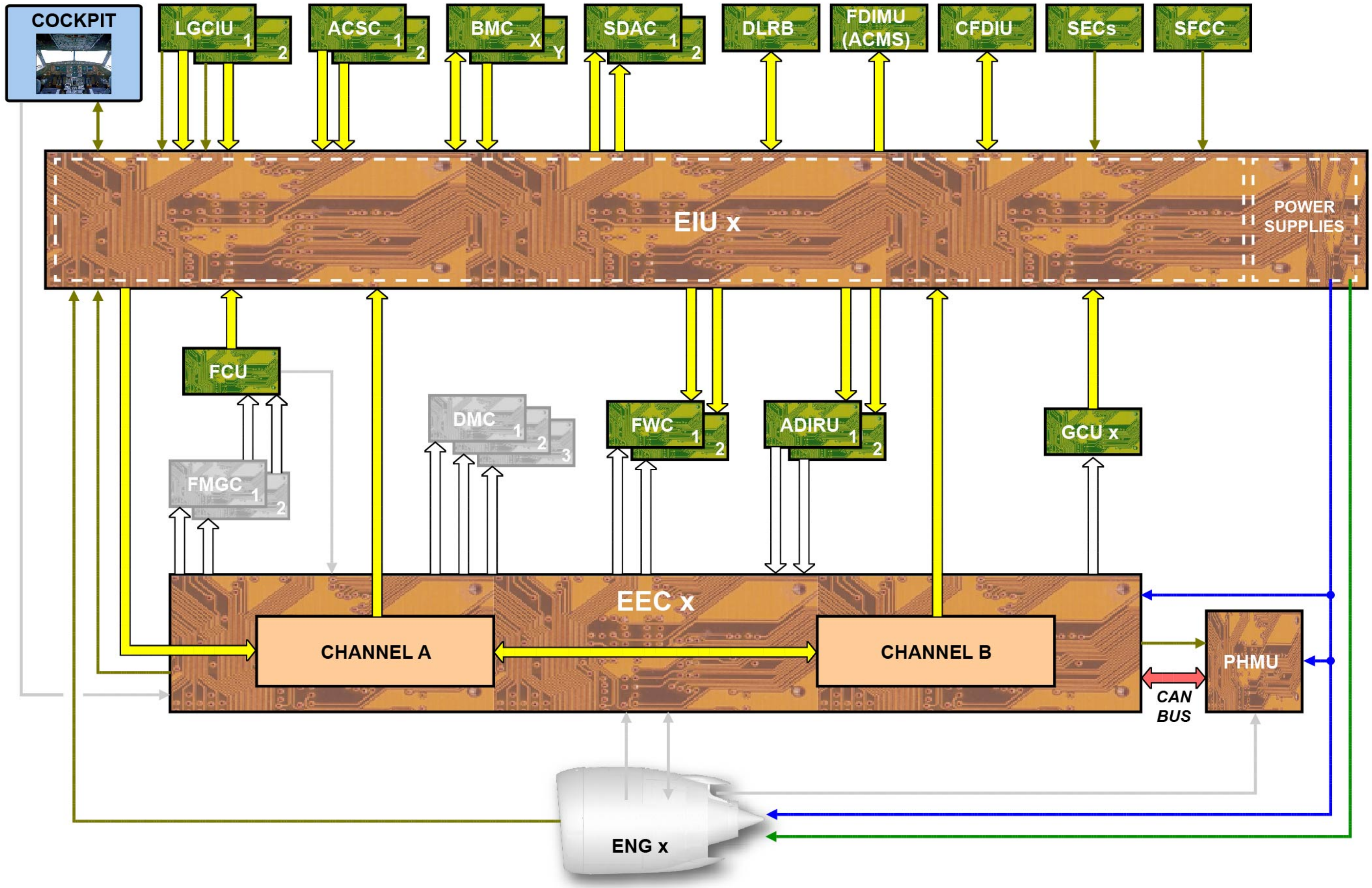
EIU #: for engine data exchange.
FMGC 1/2: for Autothrust function and TCM protection in flare.
PHMU: for vibration monitoring and trim balancing.
DMC 1/2/3: for parameters, faults and warnings display.
FWC 1/2: for warnings display.
GCU #: for power supply management.
The EEC performs the following discrete/analog exchange.

EEC discrete/analog inputs from:

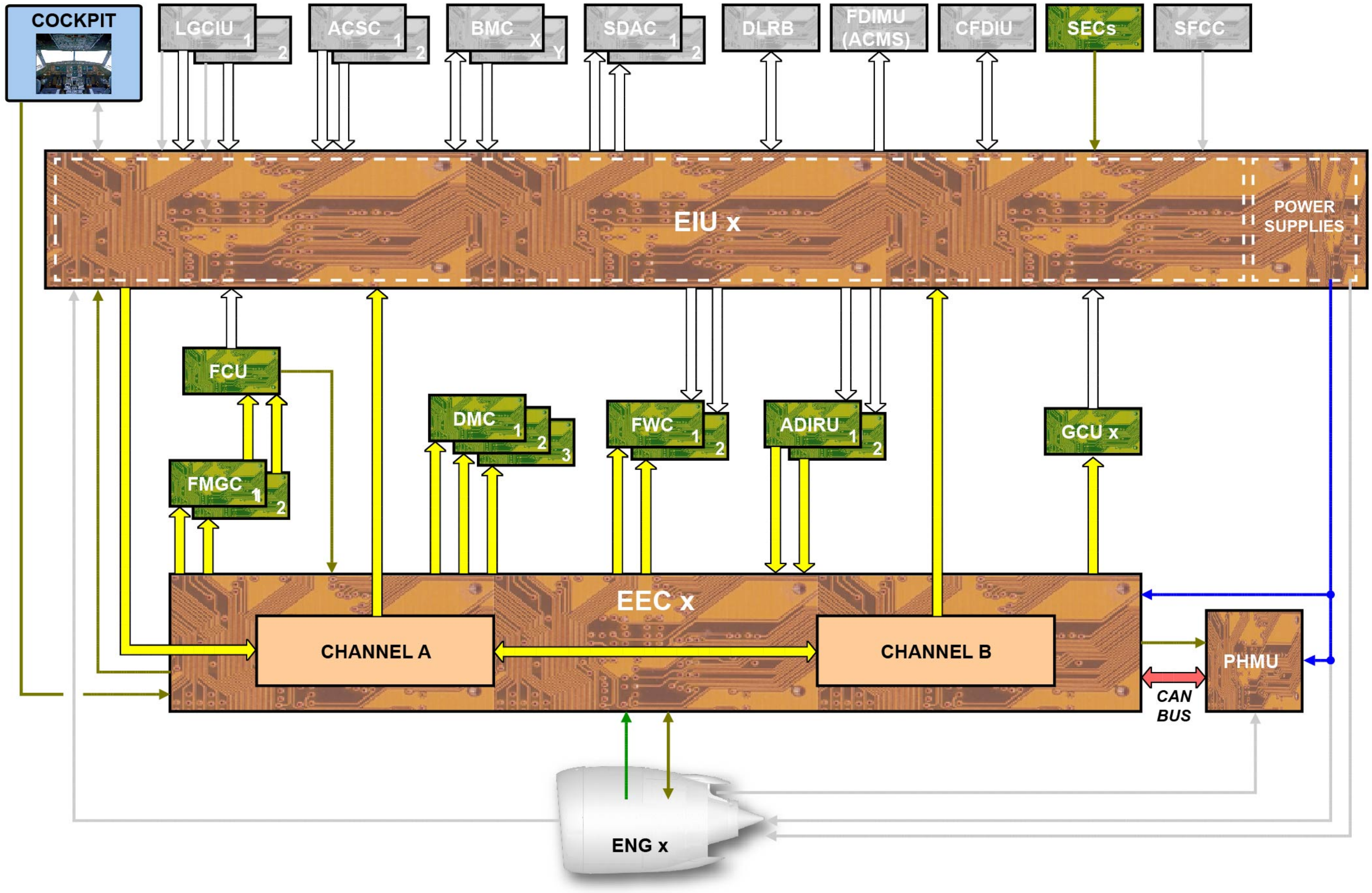
Cockpit controls:
Master lever OFF: for shutdown and reset.
Throttle position (resolvers): for manual and auto thrust control.
Autothrust disconnect P/B (ch B)
FADEC Ground Power OFF
Nacelle Anti-Ice P/B ON/OFF: for NAI control and bleed decrement computation.
FCU:
Autothrust engagement (ch B)
SECs:
TCM ground operation
Engine:
Engine sensors and subsystems feedbacks
Engine position (ch A).

EEC discrete/analog outputs to:

PHMU:
Nf (ch B), N1 (ch A), N2 (ch A)
Engine subsystems:
Control signals
EIU:
FRTTV Selected OFF.



PCS INTERFACES



PCS INTERFACES

FADEC INTERFACES (3)

FADEC INTERFACES

Unless specified differently, signals are dual (from/to both EEC channels).
The EEC is the main controller and monitoring device over the engine subsystems.

AIR SYSTEM

For the air system management, the EEC sends and receives the following data.

Compressor Stator Vane Control System:

- LPC SVA TM control signal,
- HPC master SVA Torque Motor (TM) control signal,
- LPC SVA, HPC master and slave SVAs LVDT feedback signal.

Compressor Bleed Control System:

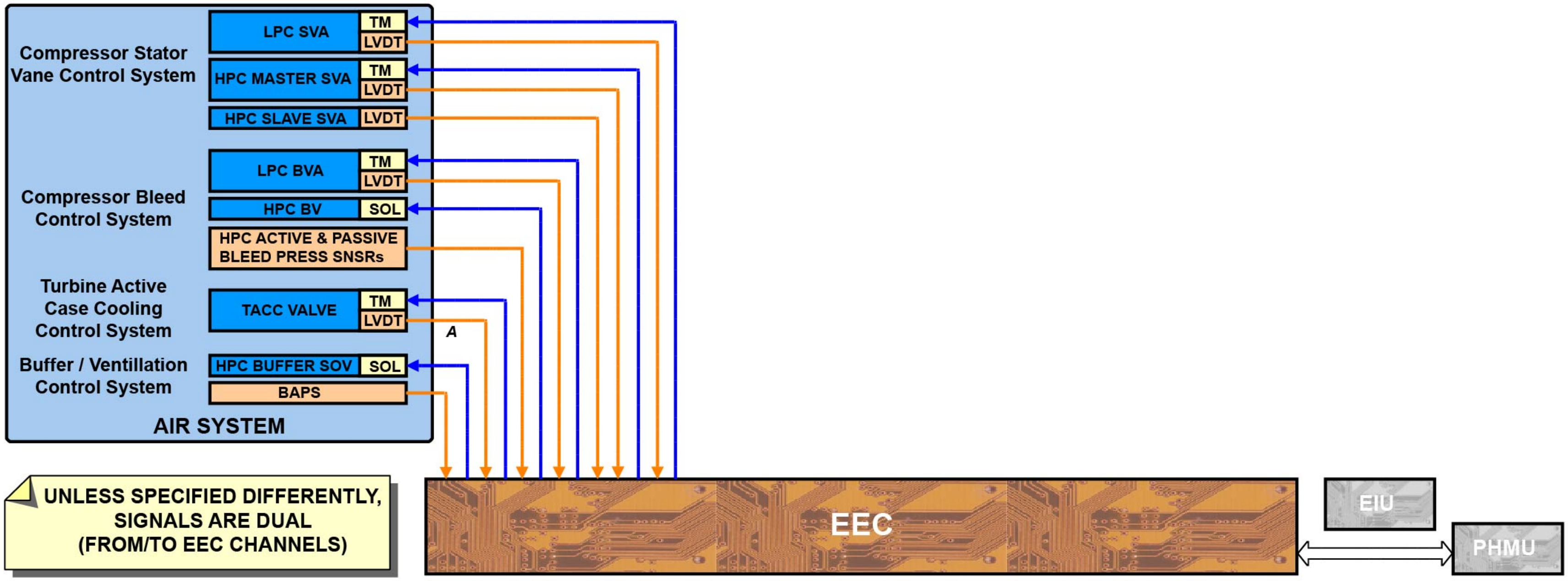
- LPC Bleed Valve Actuator (BVA) TM control signal,
- LPC BVA LVDT feedback signal,
- HPC BV solenoid control signal,
- HPC active and passive bleed pressure sensors.

Turbine Active Case Cooling Control System:

- TACC Valve TM control signal,
- TACCV LVDT feedback signal (ch A).

Buffer/Ventilation Control System:

- HPC Buffer Shut Off Valve (SOV) solenoid feedback signal,
- Buffer Air Pressure Sensor (BAPS) feedback signal.



FADEC INTERFACES - AIR SYSTEM

FADEC INTERFACES (3)

FADEC INTERFACES (continued)

FUEL SYSTEM

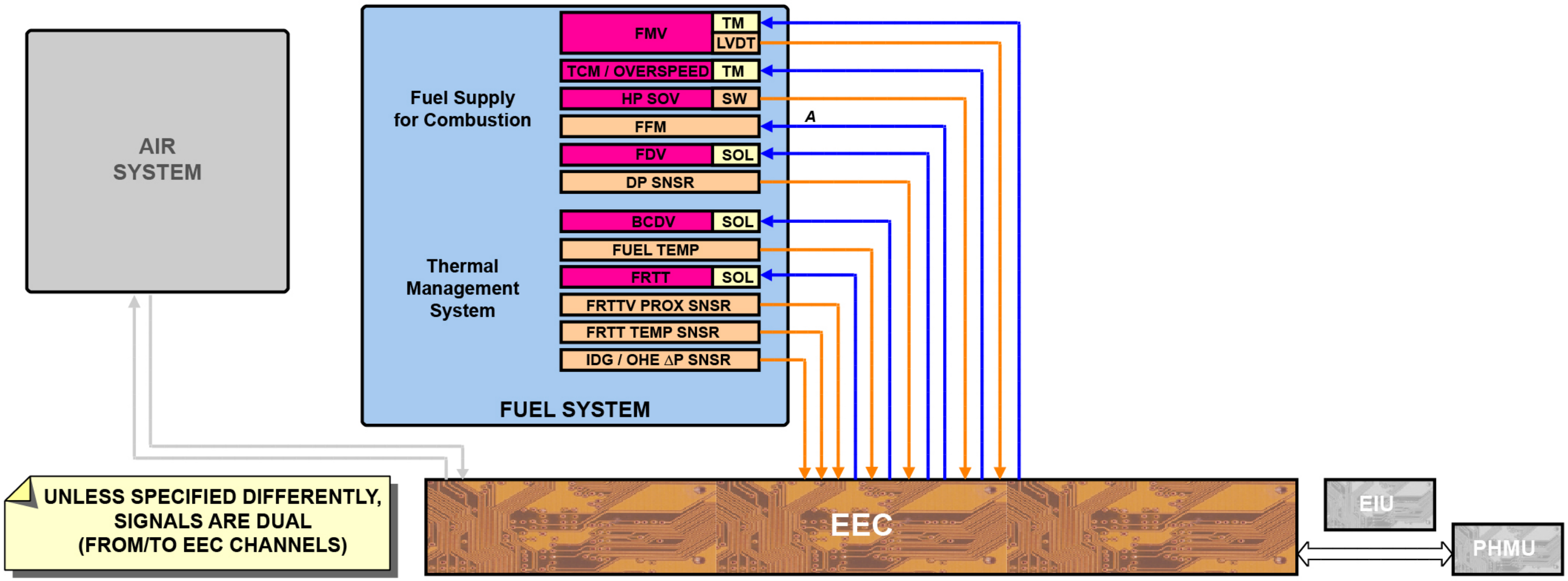
For the fuel system management, the EEC sends and receives the following data.

Fuel Supply for combustion:

- Fuel Metering Valve (FMV) TM control signal,
- FMV LVDT feedback signal,
- TCM / Overspeed TM control signal,
- HP Shut Off Valve proximity switch feedback signal,
- Fuel Flow Meter (FFM) control signal (ch A),
- Flow Divider Valve (FDV) solenoid control signal,
- Fuel Filter Differential Pressure Sensor feedback signal.

Thermal Management System:

- Bypass Direction Control Valve (BDCV) solenoid control signal,
- Fuel Temperature sensor feedback signal,
- Fuel Return To Tank (FRTT) Valve solenoid control signal,
- FRTTV Proximity Switch feedback signal,
- FRTT Temperature Sensor feedback signal,
- IDG Fuel/Oil Heat Exchanger Differential Pressure Sensor feedback signal.



FADEC INTERFACES - FUEL SYSTEM

FADEC INTERFACES (3)

FADEC INTERFACES (continued)

OIL SYSTEM

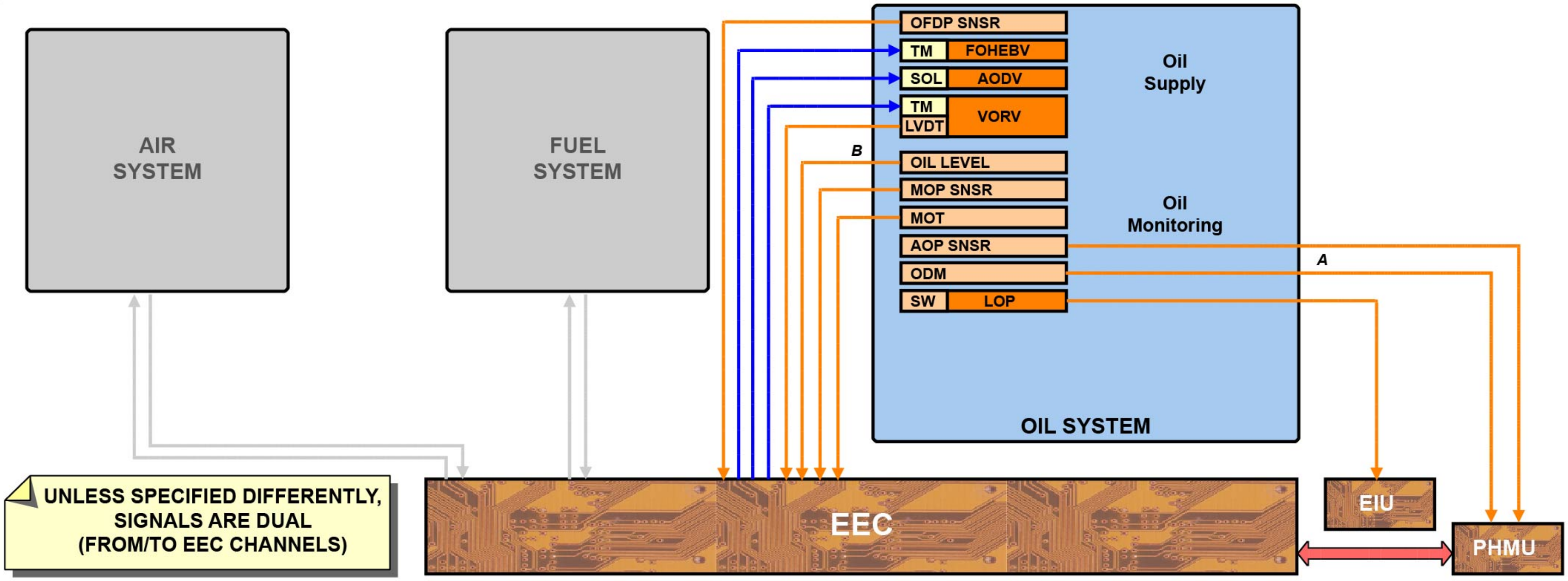
For the oil system management, the EEC sends and receives the following data:

Oil Supply:

- Oil Filter Differential Pressure sensor feedback signal,
- Fuel Oil Heat Exchanger Bypass Valve (FOHEBV) TM control signal,
- Active Oil Damper Valve (AODV) solenoid control signal,
- Variable Oil Reduction Valve (VORV) TM control signal,
- VORV LVDT feedback signal.

Oil Monitoring:

- Oil Level (OL) sensor feedback signal (ch B),
- Main Oil Pressure (MOP) sensor feedback signal,
- Main Oil Temperature (MOT) sensor feedback signal,
- Auxiliary Oil Pressure (AOP) sensor feedback signal via PHMU,
- Oil Debris Monitoring (ODM) sensor feedback signal (ch A) via PHMU,
- Low Oil Pressure (LOP) switch feedback signal to the EIU.



FADEC INTERFACES - OIL SYSTEM

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FADEC INTERFACES (3)

FADEC INTERFACES (continued)

IGNITION AND STARTING SYSTEMS

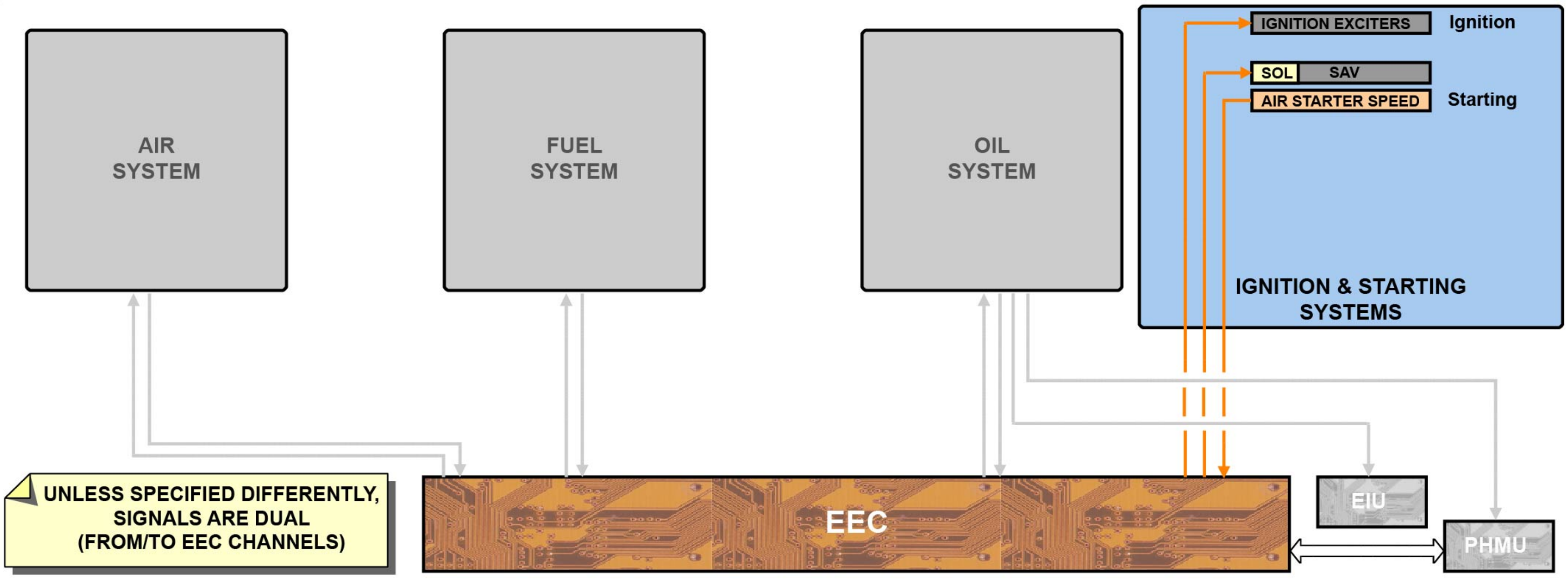
For the ignition and starting systems management, the EEC sends and receives the following data:

Ignition:

- Ignition Exciter control signal (2 pairs).

Starting:

- Starter Air Valve (SAV) solenoid control signal,
- Air starter speed sensor feedback signal.



FADEC INTERFACES - IGNITION AND STARTING SYSTEMS

FADEC INTERFACES (3)

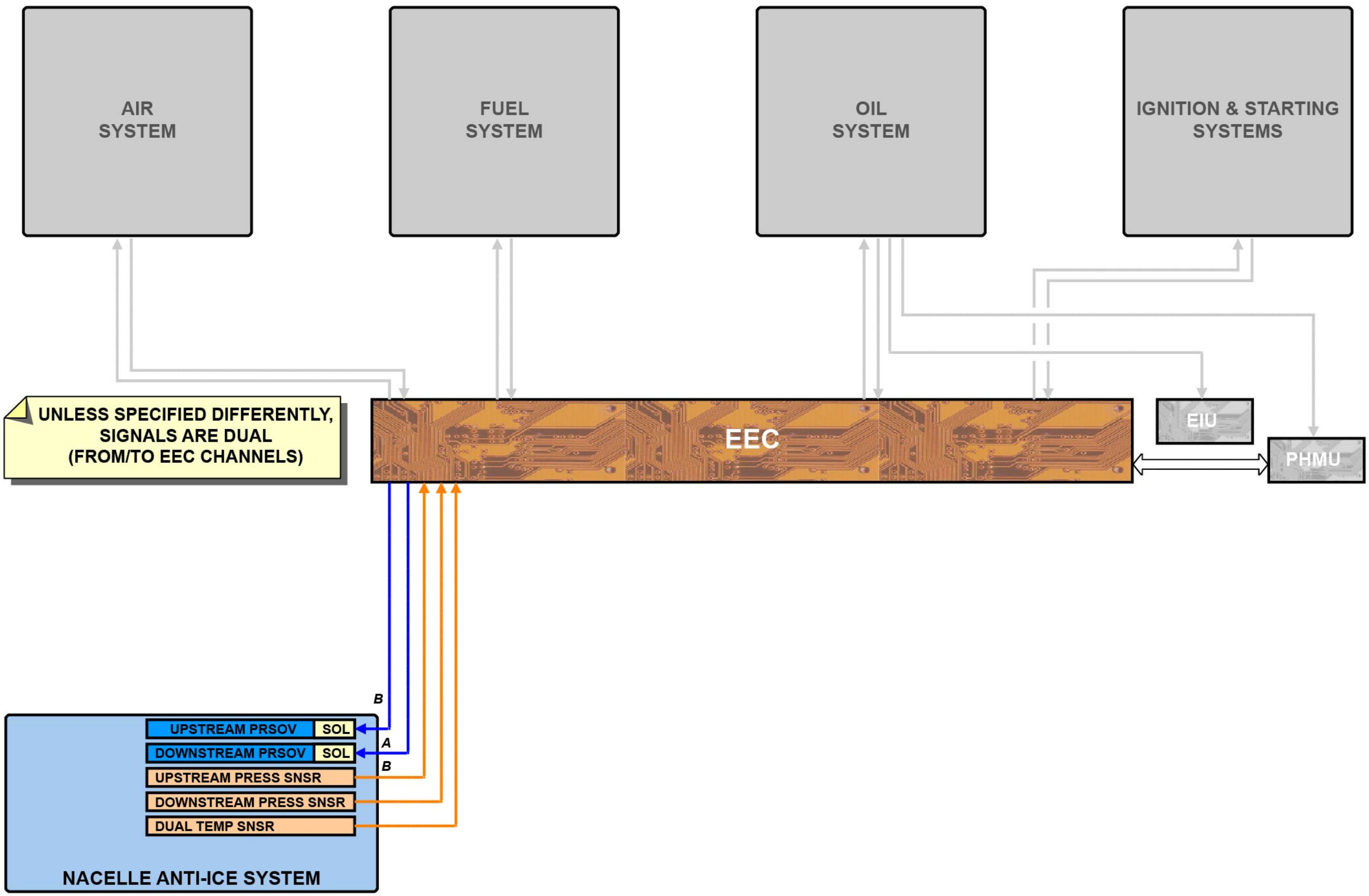
FADEC INTERFACES (continued)

NACELLE ANTI-ICE SYSTEM

For the Nacelle Anti Ice system management, the EEC sends and receives the following data:

NAI:

- Upstream PRSOV solenoid control signal (ch B),
- Downstream PRSOV solenoid control signal (ch A),
- Upstream pressure sensor feedback signal (ch B),
- Downstream pressure sensor feedback signal,
- Dual temperature sensor feedback signal.



FADEC INTERFACES - NACELLE ANTI-ICE SYSTEM

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FADEC INTERFACES (3)

FADEC INTERFACES (continued)

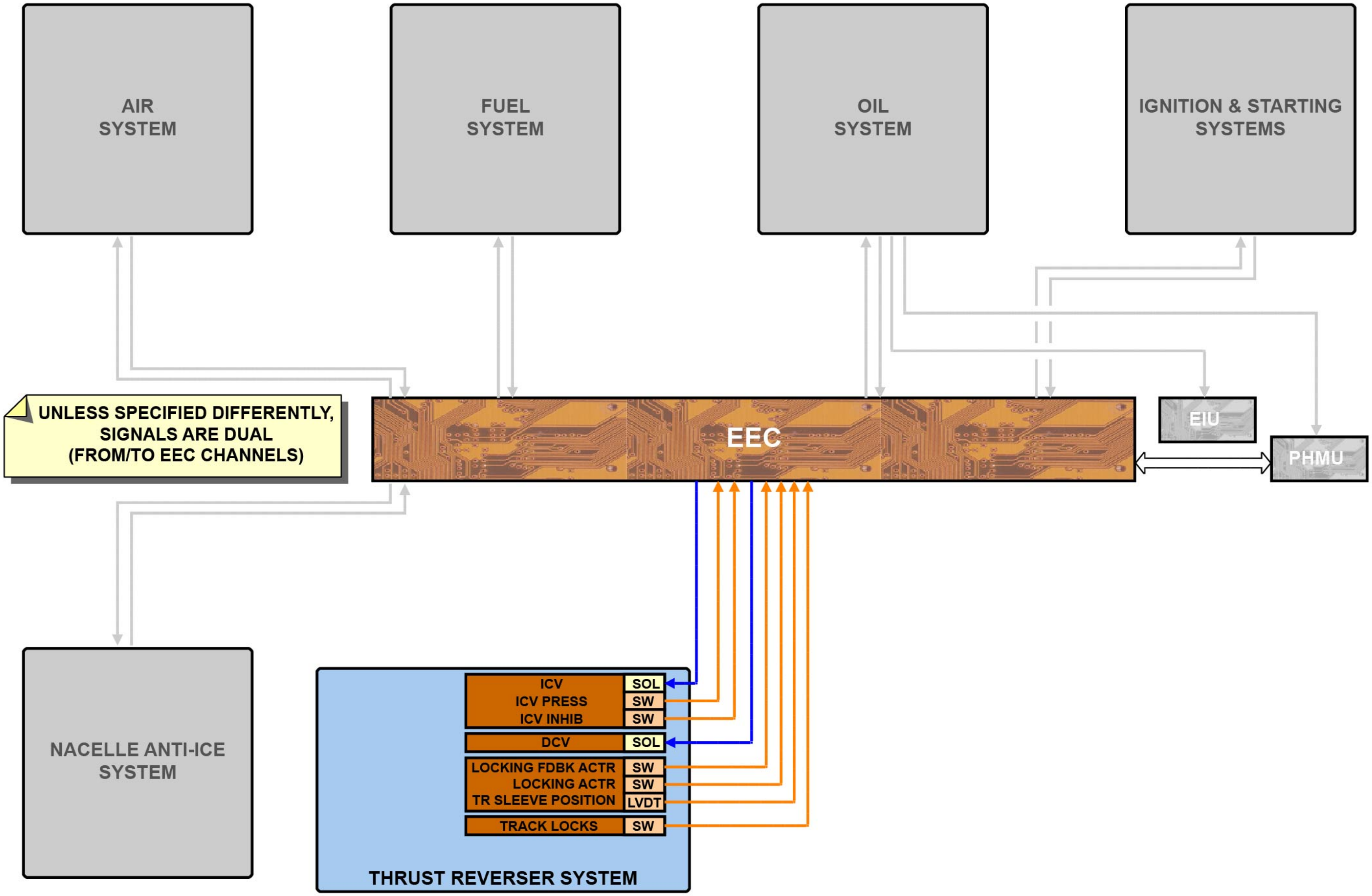
THRUST REVERSER SYSTEM

For the thrust reverser system management, the EEC sends and receives the following data.

Thrust Reverser:

- Isolation Control Valve (ICV) solenoid control signal by EIU and EEC,
- ICV pressurized proximity switch feedback signal,
- ICV inhibition proximity switch feedback signal,
- Directional Control Valve (DCV) solenoid control signal by EIU and EEC,
- Locking Feedback Actuators primary lock proximity switch feedback signal,
- Locking Actuators primary lock proximity switch feedback signal,
- Locking Feedback Actuators LVDT feedback signal,
- Track Locks proximity switch feedback signal.

NOTE: Note: Tertiary Lock Valve (TLV) solenoids are controlled independently by SEC.



FADEC INTERFACES - THRUST REVERSER SYSTEM

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FADEC INTERFACES (3)

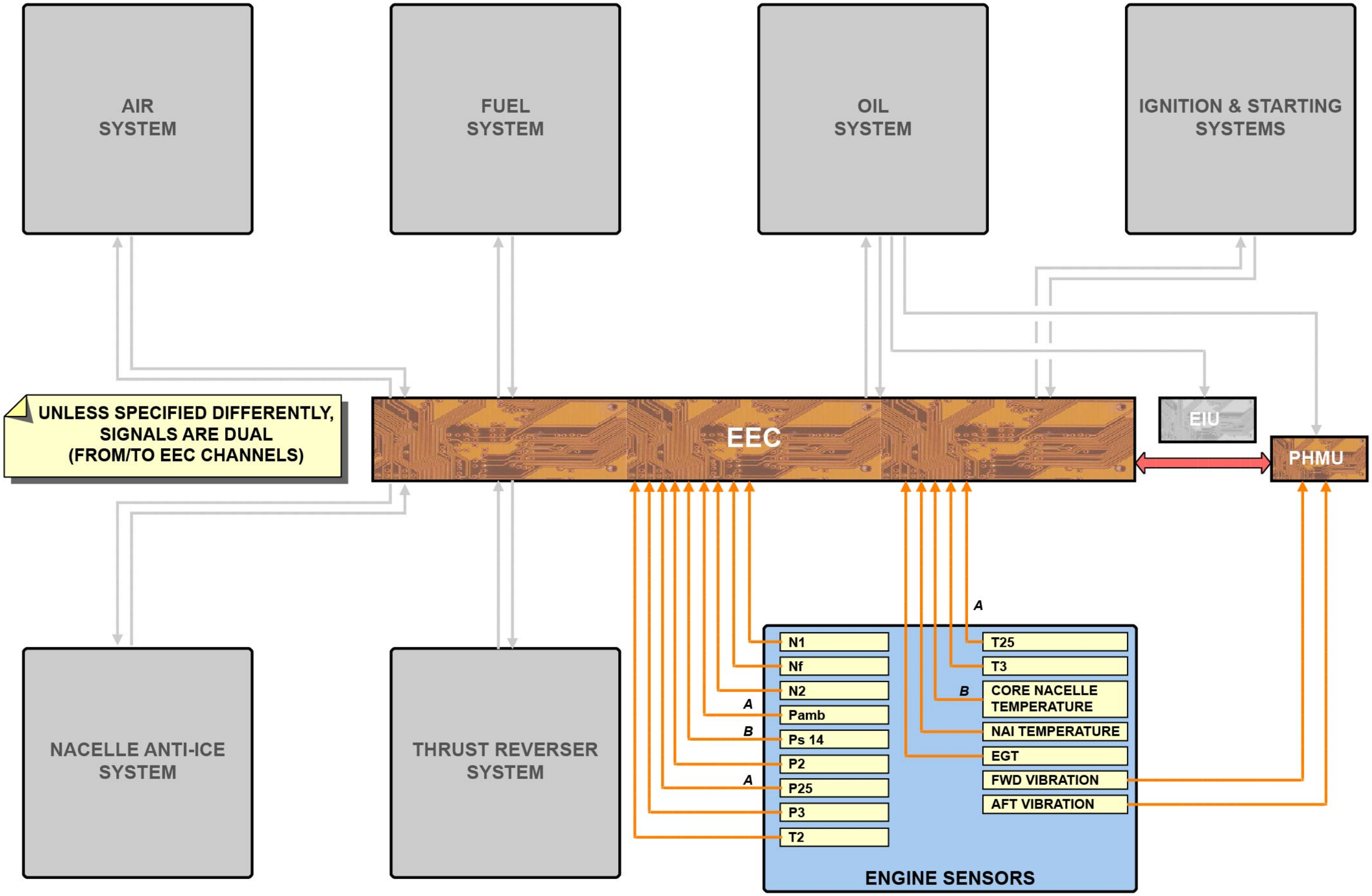
FADEC INTERFACES (continued)

ENGINE SENSORS

For the engine control and monitoring, the EEC receives the following data.

Engine Sensors:

- N1 feedback signal,
- Nf feedback signal,
- N2 feedback signal,
- P ambient feedback signal (ch A),
- Ps14 feedback signal (ch B),
- P2 feedback signal,
- P25 feedback signal (ch A),
- P3 feedback signal (2 pairs),
- T2 feedback signal,
- T25 feedback signal (ch A),
- T3 feedback signal,
- Core Nacelle Temperature feedback signal (ch B),
- NAI Temperature feedback signal,
- EGT feedback signal (2 pairs),
- Forward Vibration feedback signal to PHMU,
- Aft Vibration feedback signal to PHMU.



FADEC INTERFACES - ENGINE SENSORS

FADEC INTERFACES (3)

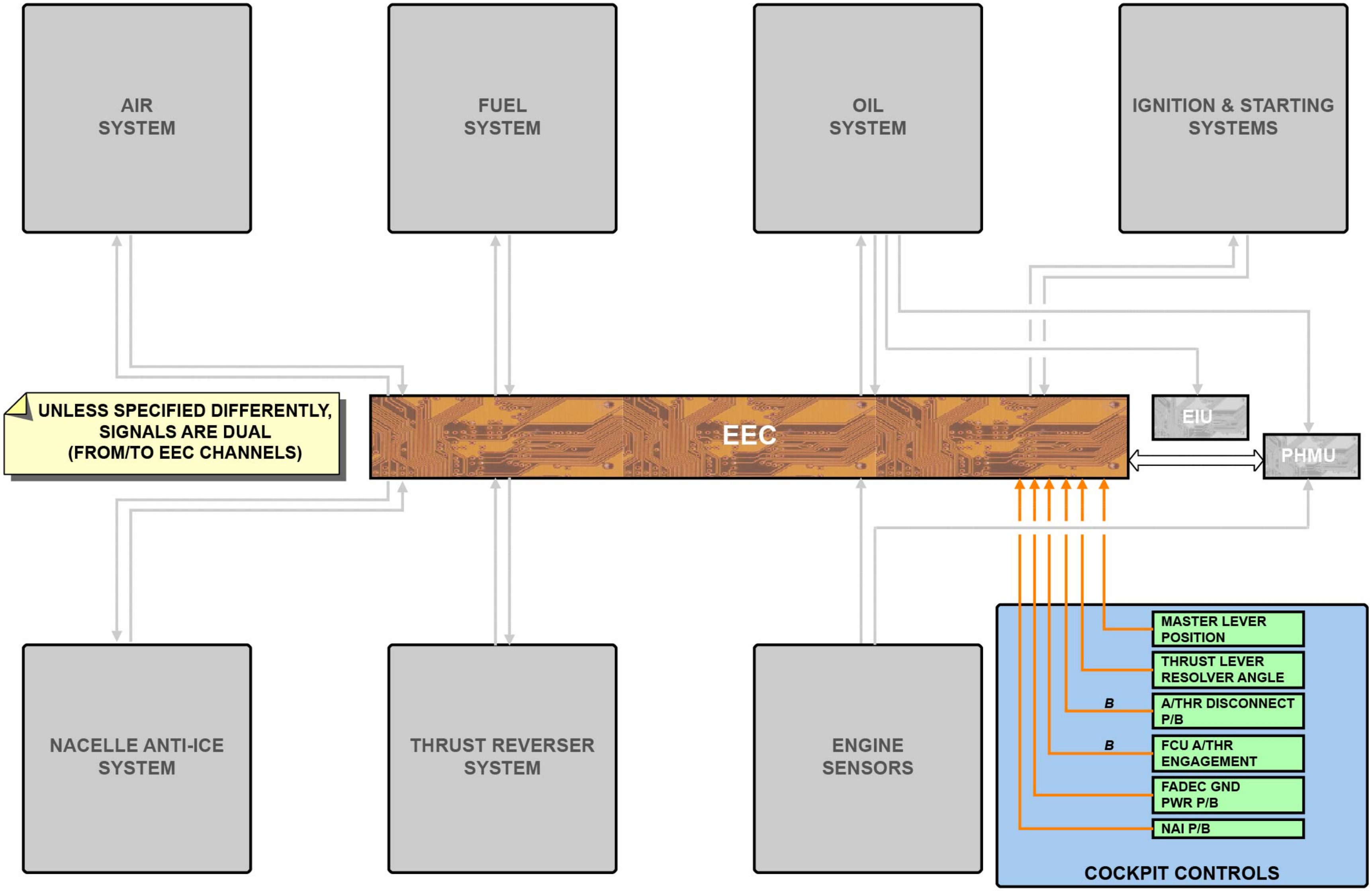
FADEC INTERFACES (continued)

COCKPIT CONTROLS

For the engine control, the EEC receives the following data.

Cockpit Controls:

- Master Lever position,
- Thrust Lever resolver angle,
- Auto Thrust (A/THR) Disconnect P/B (ch B),
- Flight Control Unit (FCU) A/THR engagement (ch B),
- FADEC Ground Power P/B,
- NAI P/B.



FADEC INTERFACES - COCKPIT CONTROLS

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FADEC ELECTRICAL PWR SPLY CONTROL (3)

EEC

The Electronic Engine Control (EEC) is electrically supplied by the A/C electrical network when high pressure rotor speed (N2) is below 10% or when the dedicated Permanent Magnet Alternator (PMA) has failed, and then by its dedicated PMA when N2 is above 10%.

AIRCRAFT POWER

The EEC is supplied by the A/C electrical power network when N2 is below 10%. Each channel is independently supplied by the A/C 28V DC through the Engine Interface Unit (EIU).
The aircraft 28V DC permits the EEC to:
- automatic ground check of the Full Authority Digital Engine Control (FADEC) system when the engine is not running, that is to say FADEC GrouND PoWeR ON for interactive tests and data loading,
- control starting: MASTER lever ON or mode selector on IGNition or CRANK, Starter Air Valve (SAV),
- control reverser system.

NOTE: The EIU takes its power from the same bus bar as the EEC.

PMA SUPPLY

As soon as the engine is running above 10% of N2, its PMA directly supplies each EEC channel with three-phase AC power. Two transformer rectifiers provide 28V DC power supply to channels A and B. Switching between the A/C 28V DC supply and the dedicated alternator power supplies is done automatically by the EEC.

AUTO DEPOWERING

The FADEC is automatically depowered on the ground, through the EIU, after engine shutdown.
The EEC automatic depowering occurs on the ground:
- 5 min after A/C power-up,
- 5 min after engine shutdown.

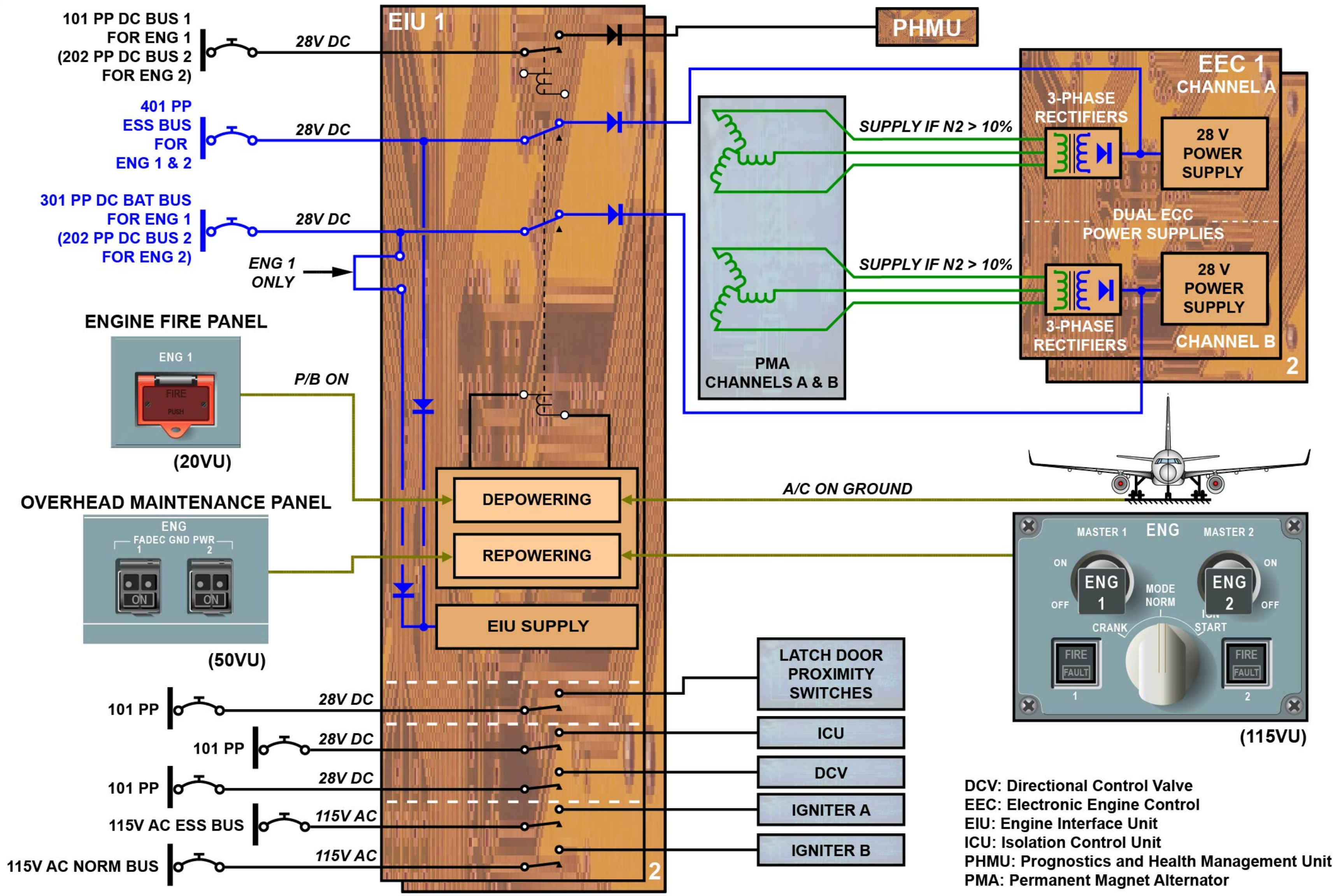
Power is not cut-off if Centralized Fault Display System (CFDS) EEC menus are active or Data Loading going on (software upload/memory dump).

NOTE: An action on the ENGine FIRE P/B provides EEC power cut-off from the A/C network.

MANUAL REPOWERING

For maintenance purposes and Multipurpose Control and Display Unit (MCDU) engine tests, the ENGine FADEC GrouND PoWeR panel permits FADEC power supply to be restored on the ground with engines shut down. When the corresponding ENGine FADEC GrouND PoWeR P/B is pressed ON the EEC recovers its power supply.

NOTE: The FADEC is also repowered as soon as the engine start selector is in IGNition/START or CRANK position, or the MASTER lever is selected ON.

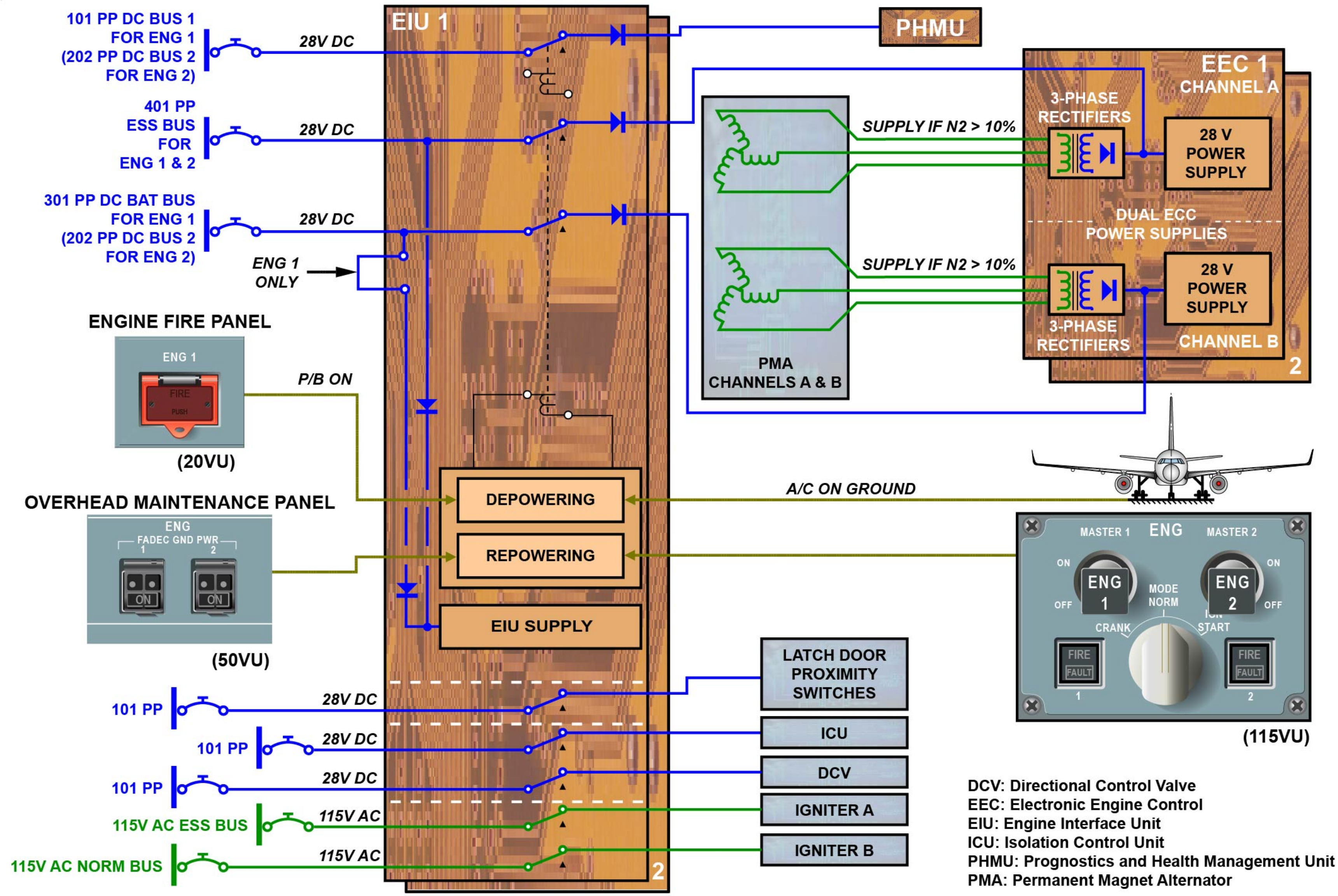


EEC - AIRCRAFT POWER ... MANUAL REPOWERING

FADEC ELECTRICAL PWR SPLY CONTROL (3)

SUBSYSTEMS POWER SUPPLY

The Prognostics and Health Management Unit (PHMU) receives aircraft 28V DC directly from the aircraft normal DC power bus through the EIU.
The de-powering conditions are the same as the EEC.
The Fan cowl door proximity switches are supplied by another bus in 28V DC.
Power is also transferred to the reverser system valves for Directional Control and Isolation.
Each starting igniter is independently supplied with 115V AC.



SUBSYSTEMS POWER SUPPLY

IGNITION & STARTING SYSTEM PRESENTATION (2)

GENERAL

The Ignition system provides the electrical spark needed to start or continue engine combustion. The ignition system is made up of two independent systems. The Ignition system includes an ignition exciter, two coaxial shield ignition leads and two igniter plugs.
The Starting system drives the engine High Pressure (HP) rotor at a speed high enough for a ground or in flight start to be initiated. The start system is made up of the electrical Starter Air Valve (SAV) and the pneumatic starter. Air bleed is taken from the aircraft pneumatic system for engine start (Auxiliary Power Unit (APU) bleed, external pneumatic cart, other engine bleed).

CONTROL AND INDICATING

The Electronic Engine Control (EEC) controls the ignition during automatic start and manual start. 115 V AC from aircraft electrical system is supplied to the ignition exciter which provides the necessary voltage to the igniter plugs to generate the spark for combustion.
The EEC controls the starting through the SAV during automatic start and manual start.
The operation of the SAV and of the ignition system is displayed on the ENGINE ECAM page.

AUTOMATIC START

During an automatic start, the EEC opens the SAV to motor the engine for start. The ignition exciter is then energized when the HP rotor speed is nominal. The EEC provides full protection during the start sequence. When the automatic start is completed, the EEC closes the SAV and cuts off the ignition. In case of an incident during the automatic start the EEC makes a second attempt or aborts the start procedure.

MANUAL START

During a manual start, the SAV opens when the engine MANual START P/B is pressed in, then the ignition system is energized when the MASTER control lever is set to the ON position.

NOTE: there is no automatic shutdown function or second attempt in MANUAL START.

CRANKING

Engine motoring could be performed for dry cranking or wet cranking sequences.

NOTE: during cranking ignition is inhibited.

CONTINUOUS IGNITION

With engine running, continuous ignition can be selected via the EEC either manually using the rotary selector or automatically by the Full Authority Digital Engine Control (FADEC) during specific conditions.

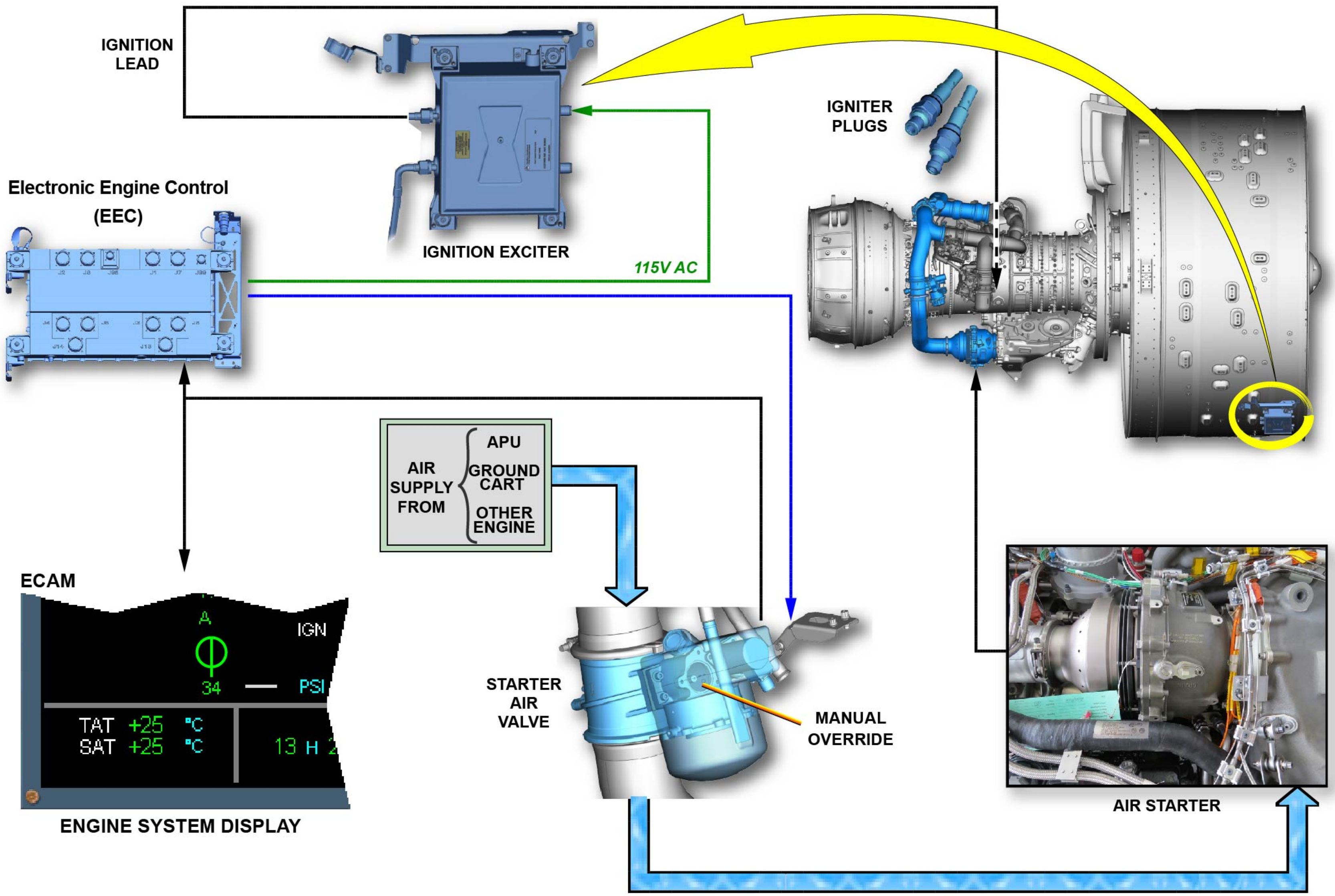
SAFETY PRECAUTIONS

Safety precautions have to be taken prior to working in this area.

WARNING: THE IGNITION EXCITER PROVIDES HIGH ENERGY PULSES THROUGH THE IGNITION LEADS TO THE 2 IGNITERS PLUGS.

MAINTENANCE PRACTICES

To increase A/C dispatch reliability, the SAV is equipped with a manual override. For this manual operation, the mechanic has to be aware of the engine safety zones.

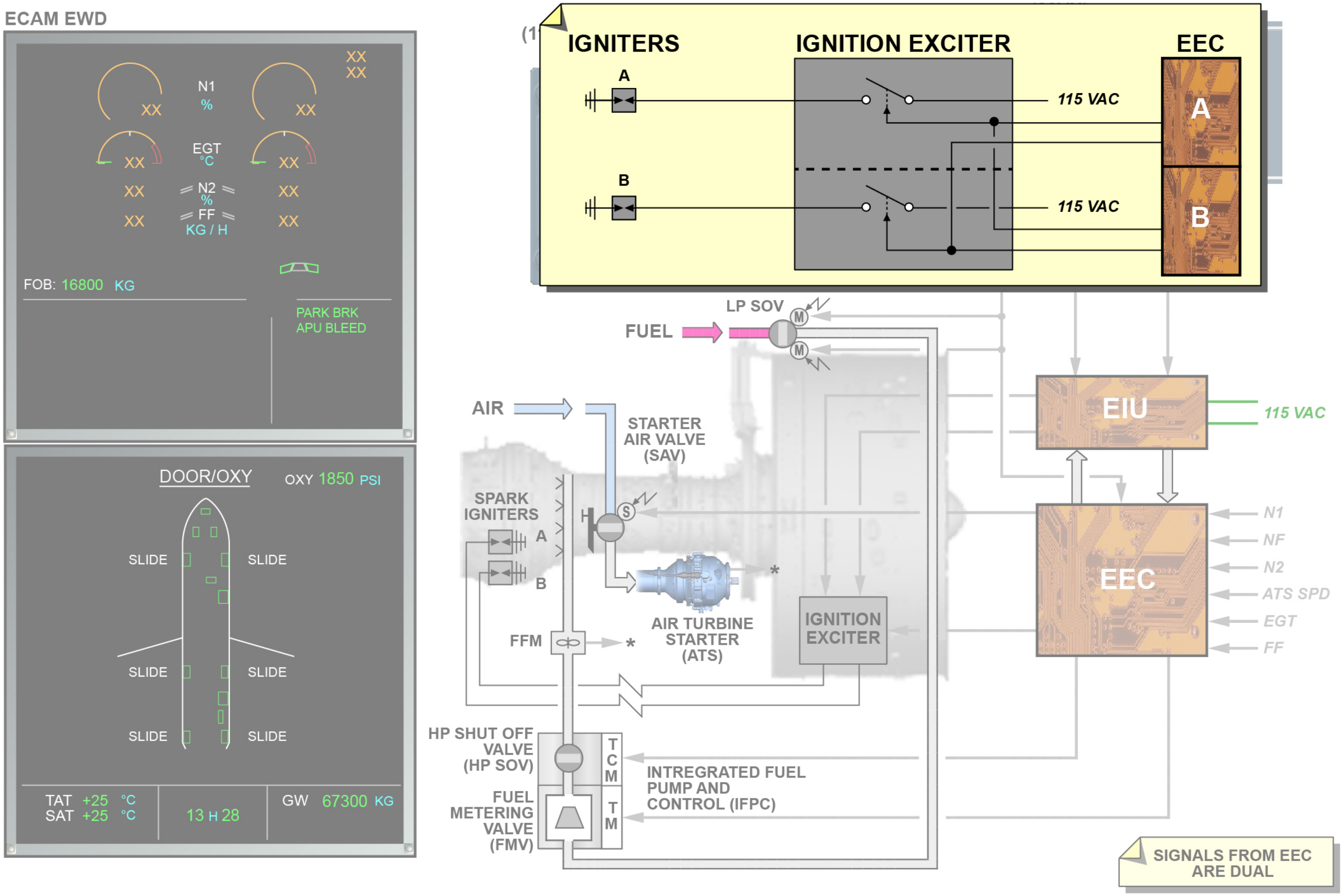


GENERAL ... MAINTENANCE PRACTICES

IGNITION & STARTING SYSTEM D/O (ME) (3)

GENERAL

The Electronic Engine Control (EEC) controls and monitors the Starting and Ignition systems for engine starting, cranking, and ignition selection, on ground and in flight.
For engine starting, two modes are available; automatic or manual.
Both modes can be used on ground or in flight but in flight sequence are less protective to enhance the restart capability.
For engine cranking, two sequences can be manually selected: dry or wet.
The EEC controls the starting and ignition components according to cockpit commands and protective logics.
The main engine parameters to be monitored during starting are displays on the E/WD (N1, EGT, N2, Fuel Flow) and on the SD (Oil Press, IGN system, Starter Air Valve position and available pneumatic pressure).
The ignition system is composed of a dual channel ignition exciter supplying two spark igniter plugs.
Each plug and corresponding circuit (identified as system A and system B) can be used at the same time or alternately to detect dormant failures.
The EEC controls the ignition by providing command signals to the internal relays of the ignition exciter, whereas the EIU supplies 115 Volt power supply to the ignition exciter.
The starting system consists of a Starter Air Valve (SAV), air duct and an Air Turbine Starter (ATS).
The SAV is electrically controlled by the EEC and pneumatically operated.
The ATS is attached to the aft of the main gearbox at the 5 o'clock position. It is fitted with a speed sensor which is used for system control and monitoring by the EEC.
The pressurized air supply to the starting components is provided by one of the following sources:
- Auxiliary Power Unit (APU) bleed,
- external pneumatic ground cart,
- engine bleed from the opposite engine.



GENERAL

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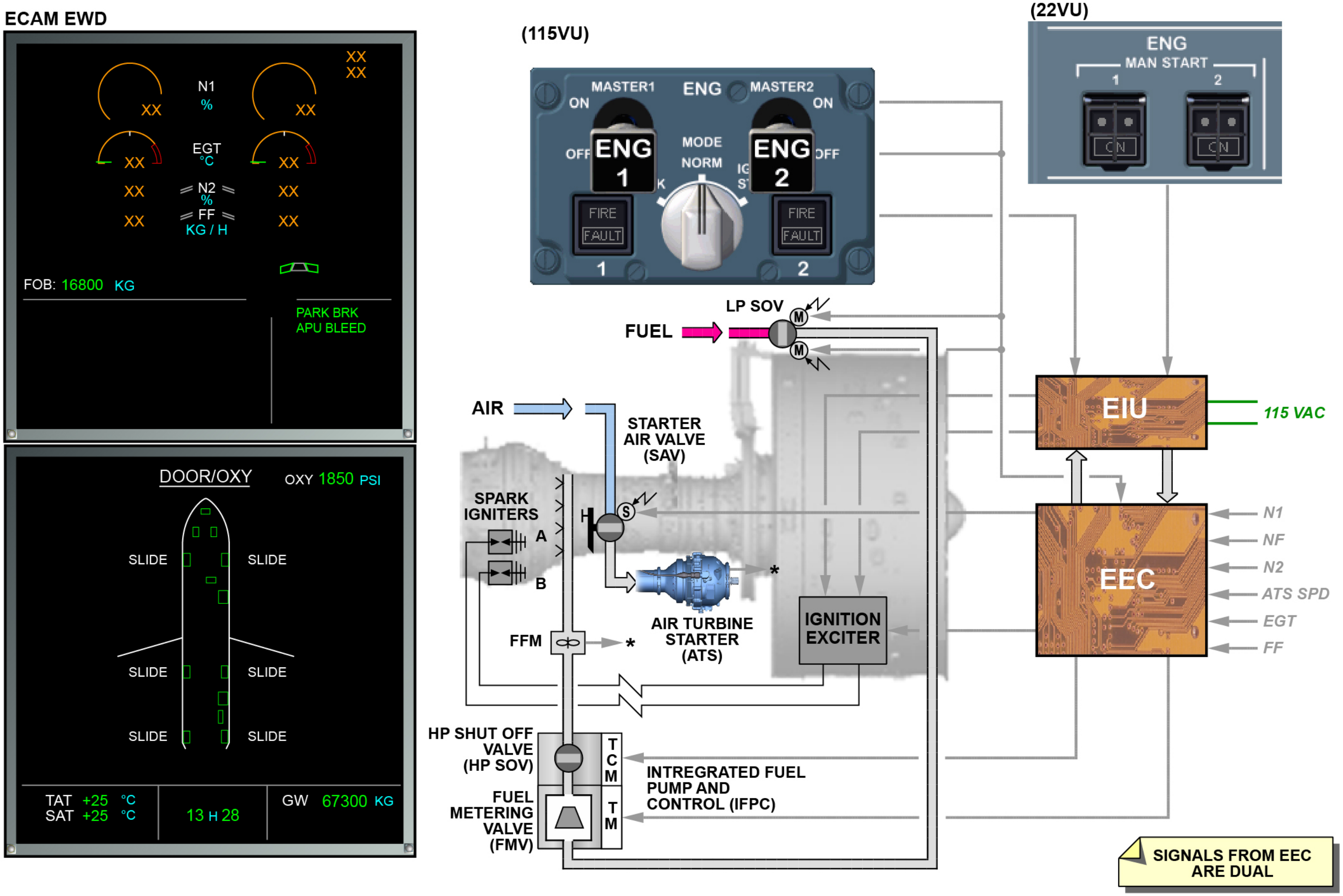

GENERAL

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IGNITION & STARTING SYSTEM D/O (ME) (3)

AUTOMATIC START

The EEC shall enter the automatic start mode when all of the following conditions are true:
- the engine is not running, and
- the selected rotary selector is set to IGN/START, and
- the selected ENG MASTER lever is set to ON, and
- the ENG MAN START pushbutton is OFF.

When the ENG MODE rotary selector is set to IGN/START position, FADEC is powered up.
The ENGINE page is automatically shown on the System Display (SD) page of the ECAM system.
The ENGINE page displays the IGN indication, SAV position and bleed pressure during this sequence.
At the same time, the APU bleed demand will increase and the pack valves will close.
As soon as the ENG MASTER lever is set to ON position, the LPSOV opens and the automatic starting sequence begins.
The EEC will automatically control the:
- Thrust Control Malfunction (TCM) cutback test,
- HPC active bleed valve (opening and closing),
- Hydraulic pump depressurizing (via EIU) if necessary during in flight restart,
- SAV (opening and closing),
- Igniters (one or two, on and off),
- Fuel Flow (FMV and HPSOV opening).

First, the EEC energizes the SAV solenoid. This supplies the starter with aircraft pneumatic pressure.
The position of the SAV is confirmed open at the bottom of the ENGINE page thanks to the ATS speed sensor feedback.
Consequently, the N2 begins to increase.
When the engine reaches the minimum fuel pressurization speed (18% N2), the EEC activates one igniter and controls the appropriate fuel flow to the burner.
On the SD ENGINE page, the corresponding spark igniter system (A or B) controlled by the EEC comes into view.
On the E/WD, the FF increases.
Fuel is sent to the burner via the Fuel Metering Valve (FMV) and the High Pressure Shut Off Valve (HPSOV) in the Integrated Fuel Pump and Control (IFPC).
The EEC monitors the Exhaust Gas Temperature (EGT) and N2 according to their schedules to provide the correct fuel flow for a good acceleration.
When N2 reaches 51% N2, the automatic start sequence ends when the EEC controls the SAV to close and the igniter to OFF.
The engine continues to accelerate and stabilizes at idle speed.
The usual standard parameters are:
- N1 = 19%,
- N2 = 58%,
- EGT = 440 ºC,
- FF = 227 kg/h.

If the second engine has to be started, the ENG MODE rotary selector should stay on the IGN/START position.
This will avoid activating the continuous ignition on the running engine if the selector is cycled to NORM and again to IGN/START.
When both engines are running, the selector is set back to NORM, the WHEEL page will appear instead of the ENGINE page if at least one engine running.
Automatic start abort:
The EEC has the authority to abort a start only on the ground.
The EEC will abort the start, dry motor the engine for 30 seconds and attempt a single start for the following reasons:
- no light up (EGT low and constant),
- no N2 acceleration (hung start),
- EGT reaches starting limit (impending hot start).

NOTE: The maximum EGT during start sequence is 700º C.

The EEC will abort a start, dry motor the engine for 30 seconds and not attempt a restart for the following conditions:

- Failure of automatic restart,
- N1 locked rotor,
- EEC unable to command both igniters,
- Loss of EGT indication (T5 sensors failed),
- EEC unable to control fuel flow.

The EEC will also abort a start, will not dry motor the engine and will not attempt a restart if the starter duty cycle is exceeded.

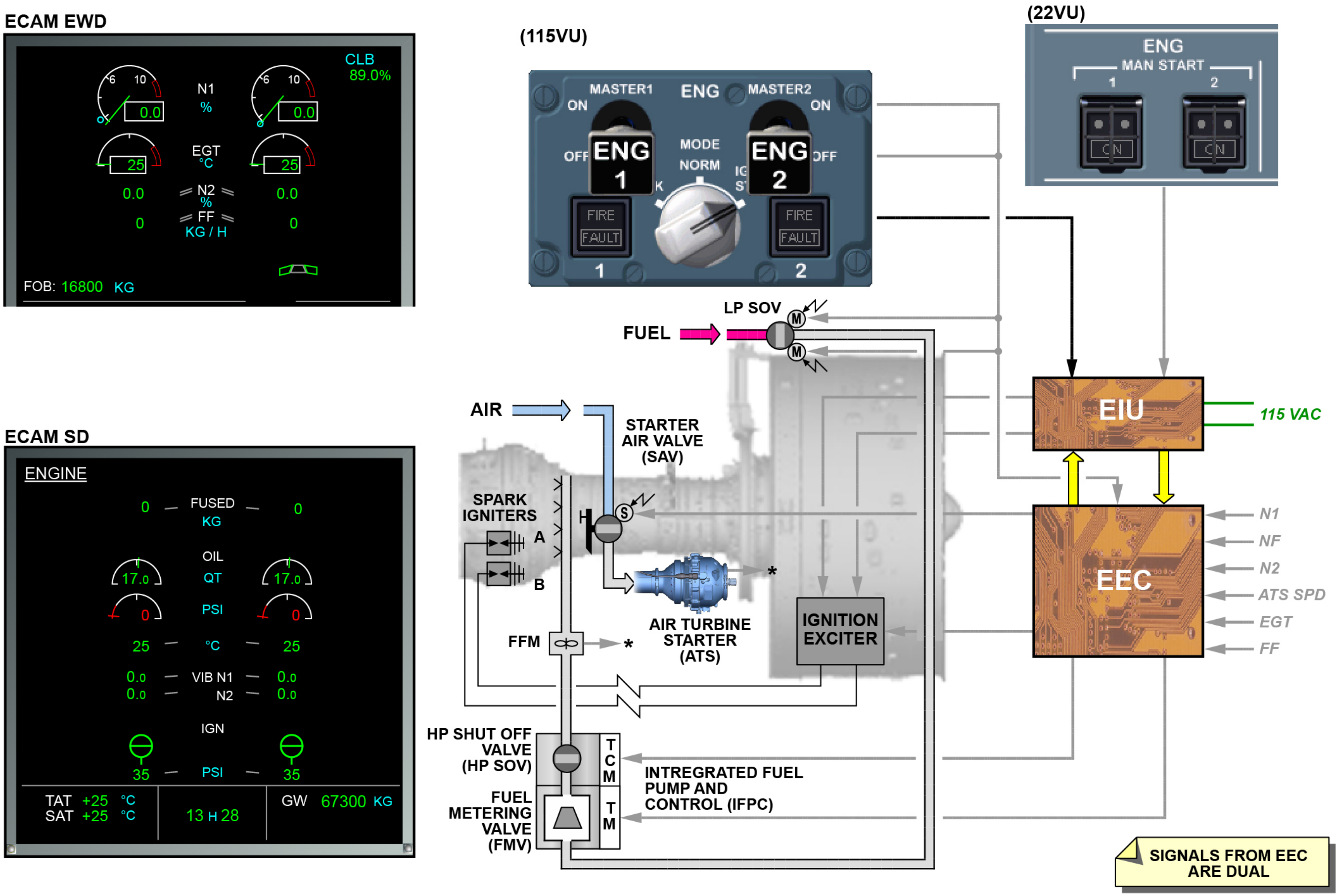
Manual start abort:

The automatic start sequence can be manually aborted by selection of the ENG MASTER lever to OFF position.

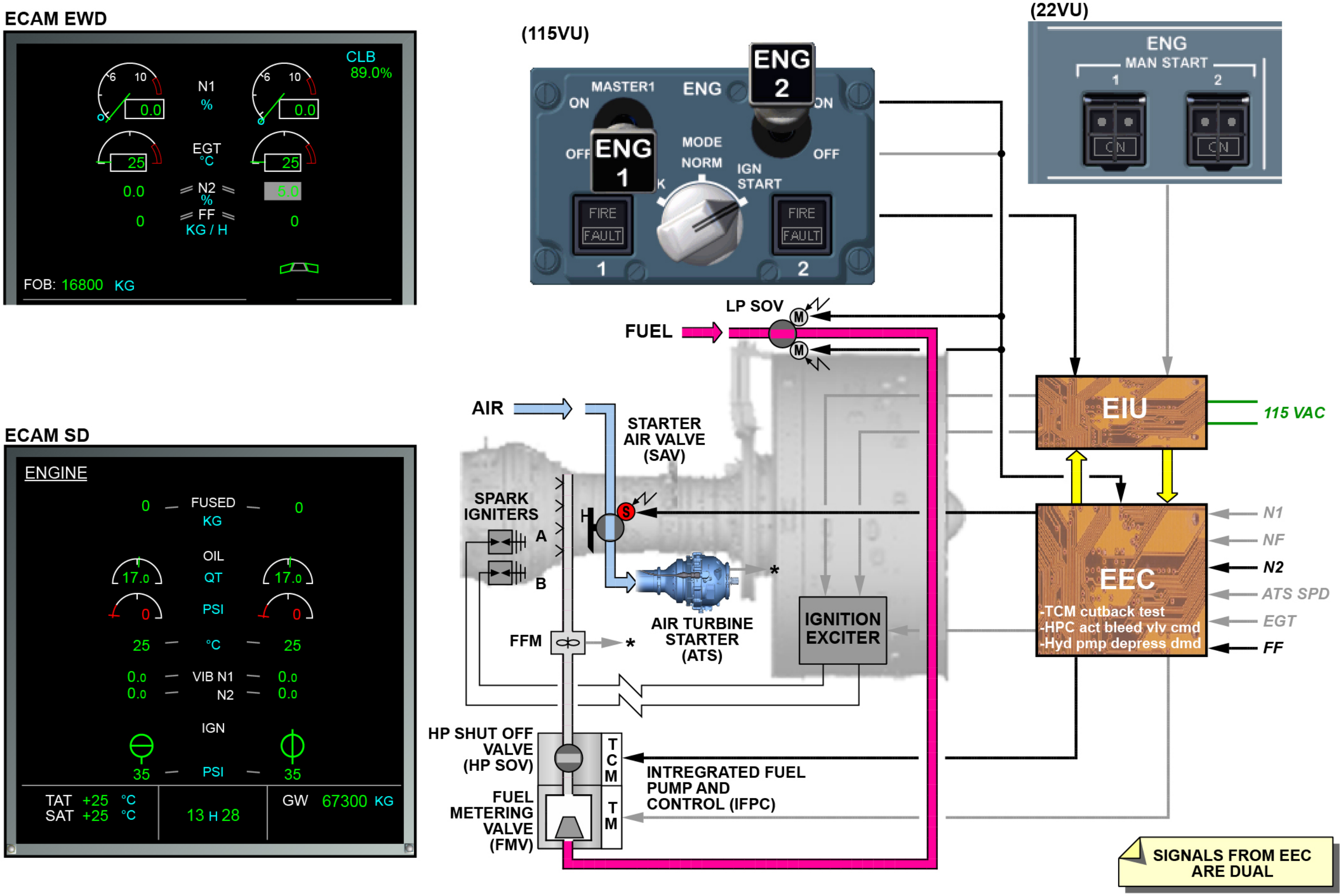
This leads to:

- SAV closure,
- Igniter(s) off,
- FMV, LP and HP fuel shut-off valves closure.

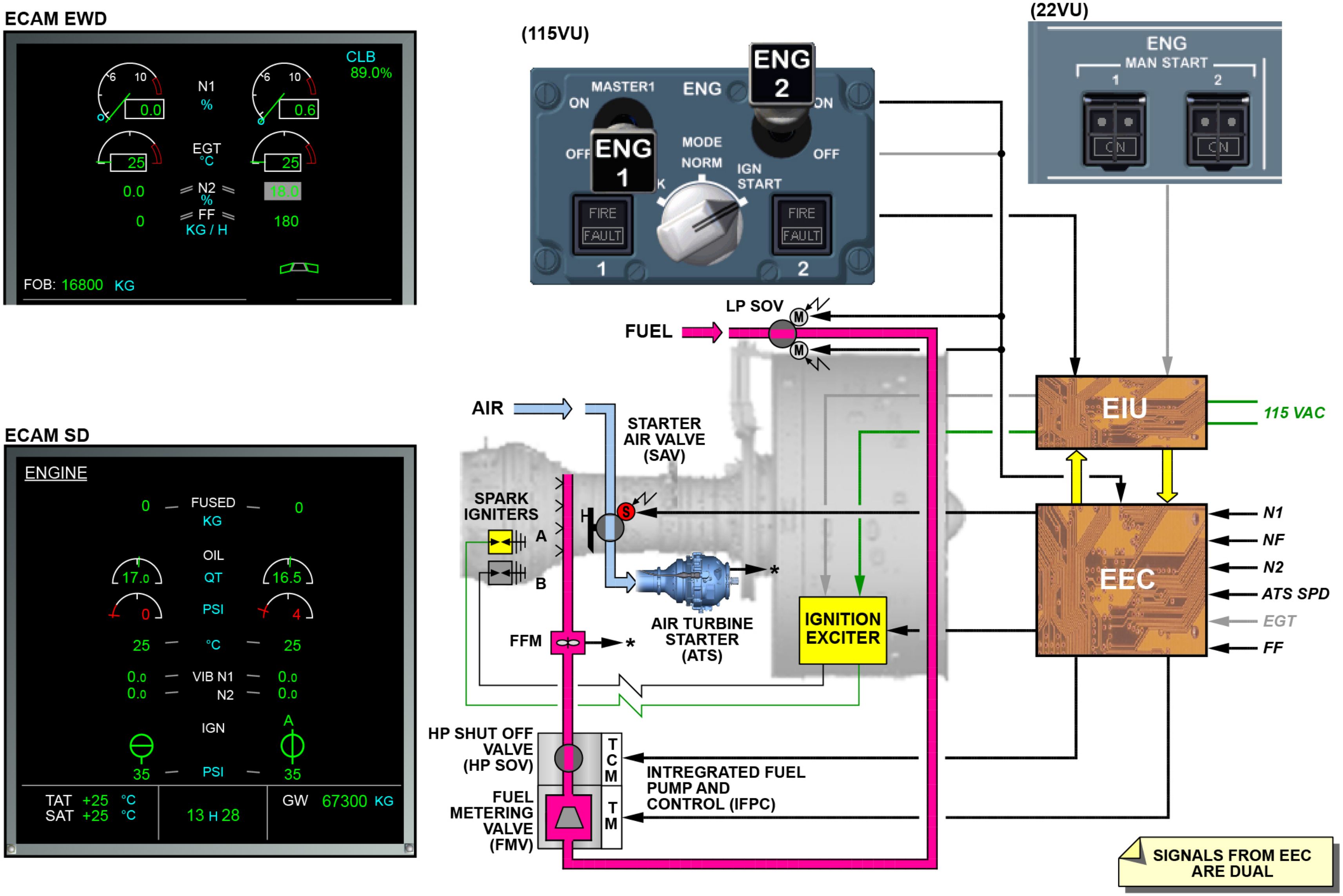
NOTE: EEC does not dry motor the engine when an automatic start is manually aborted.



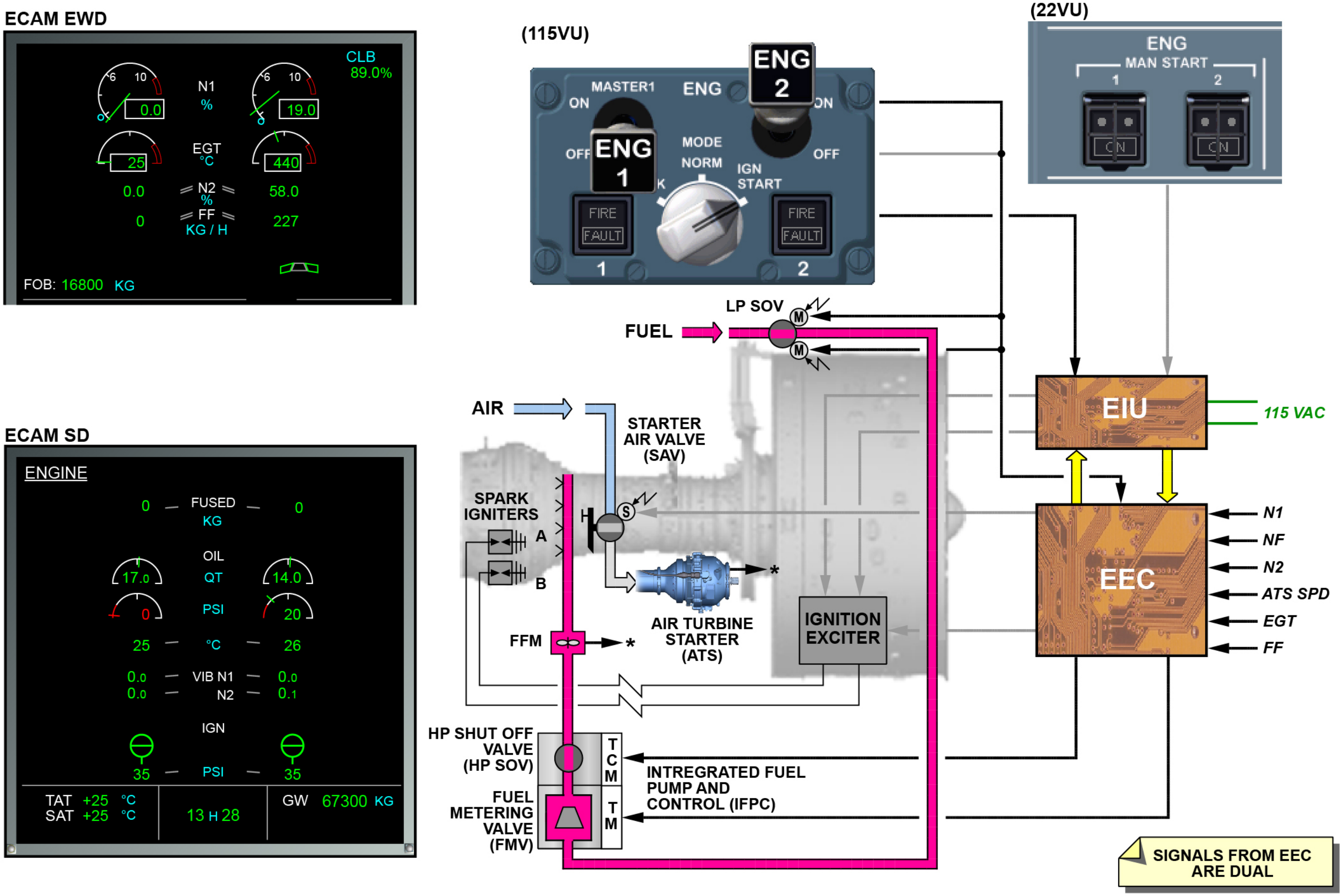
AUTOMATIC START



AUTOMATIC START



AUTOMATIC START



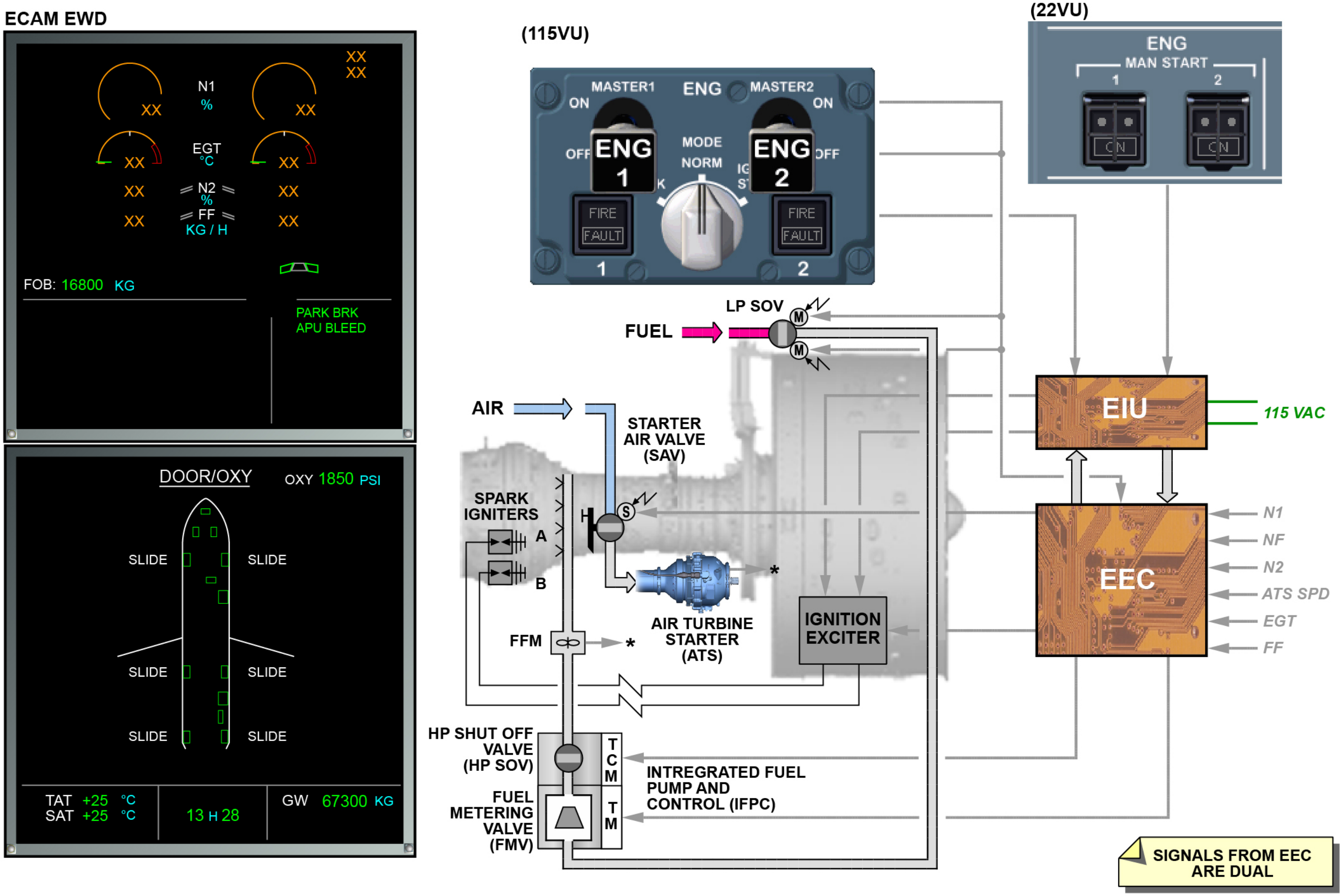
AUTOMATIC START

IGNITION & STARTING SYSTEM D/O (ME) (3)

MANUAL START

A manual engine start procedure is included in the EEC engine starting logic.
In the manual start mode, engine starting control is under limited authority of the EEC.
The SAV, fuel, and ignition are controlled from the cockpit via the EEC.
Bleed air source being available, a manual start sequence is commanded by first setting the rotary selector to the IGN/START position to power and signal the EEC.
The ENGINE page appears on the SD page of the ECAM.
The ENGINE page displays the IGN indication, SAV position and bleed pressure during this sequence.
At the same time, the APU bleed demand will increase and the pack valves will close.
The next action is to engage the ENG MAN START push-button to the ON position. This will lead the EEC to open the SAV.
When N2 is above the minimum fuel pressurization speed (on-ground approximately 18% N2), the ENG MASTER lever is set to the ON position. The EEC commands fuel flow and both igniters simultaneously.
The EEC monitors the EGT and N2 according to their schedules to provide the correct fuel flow but EGT limit protection is inactive.
When N2 reaches 51% N2, the manual start sequence automatically ends when the EEC controls the SAV to close and the igniters to OFF.
The engine continues to accelerate and stabilizes at idle speed.
Manual start abort:
When a manual engine start has been initiated on ground or in flight, it shall be interrupted by either:
- de-selecting the ENG MAN START push-button before the ENG MASTER lever is commanded ON, or
- selecting ENG MASTER lever back to OFF position after it has already been selected ON.

Interruption of a manual start shall result in the following EEC commands:
- SAV closure,
- igniters off,
- FMV and HP fuel shut-off valve closure.



MANUAL START

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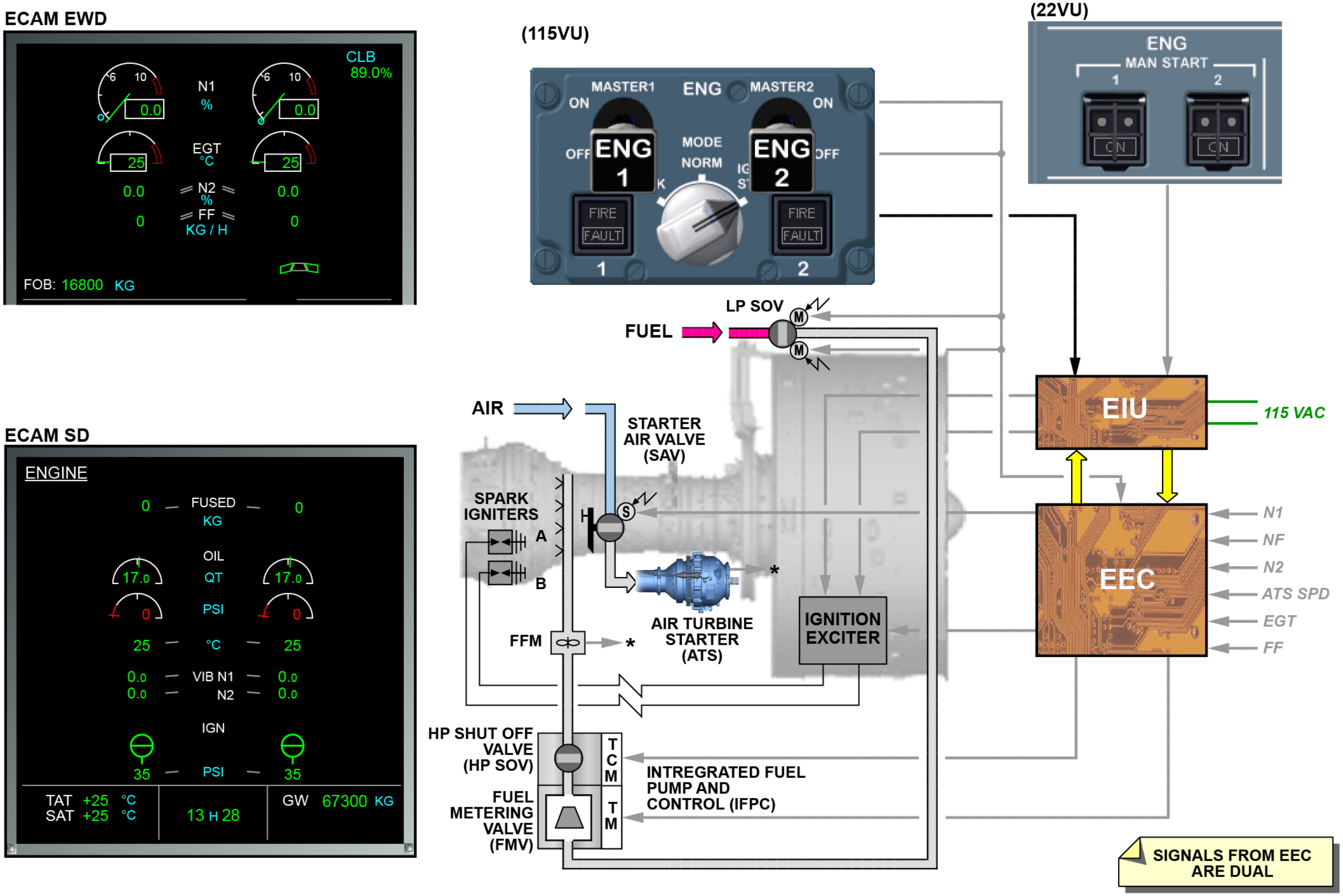

MANUAL START

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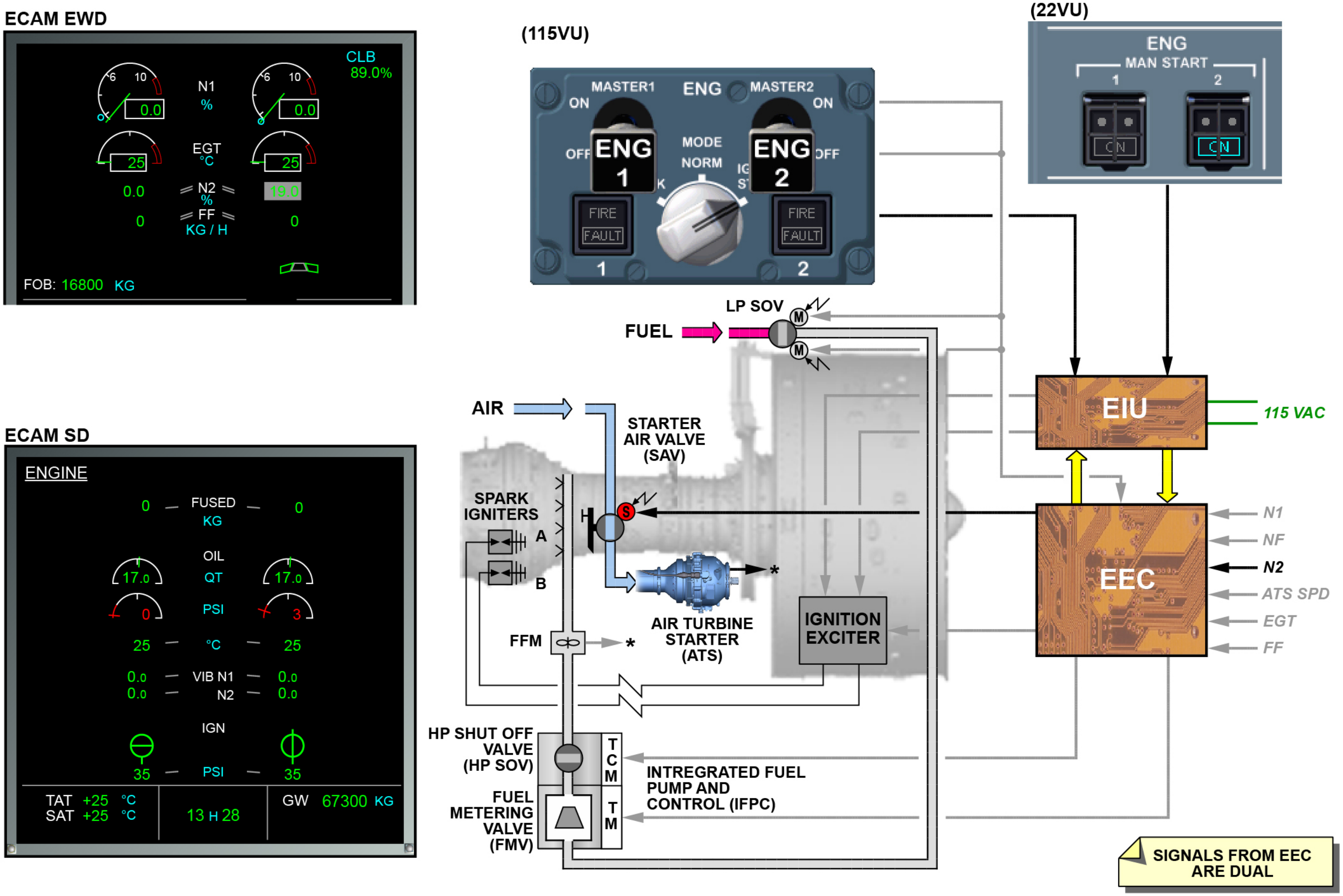

MANUAL START

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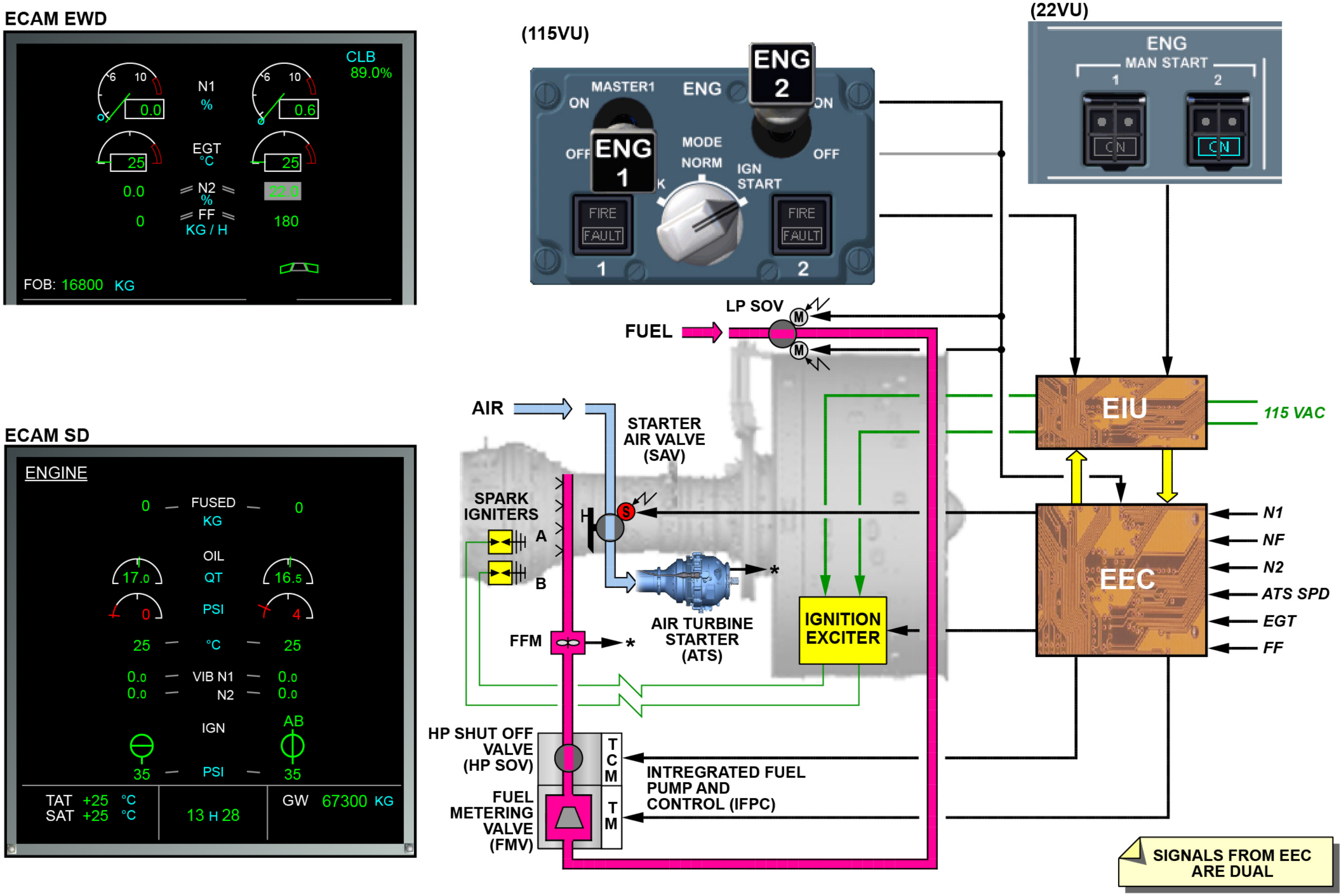

MANUAL START

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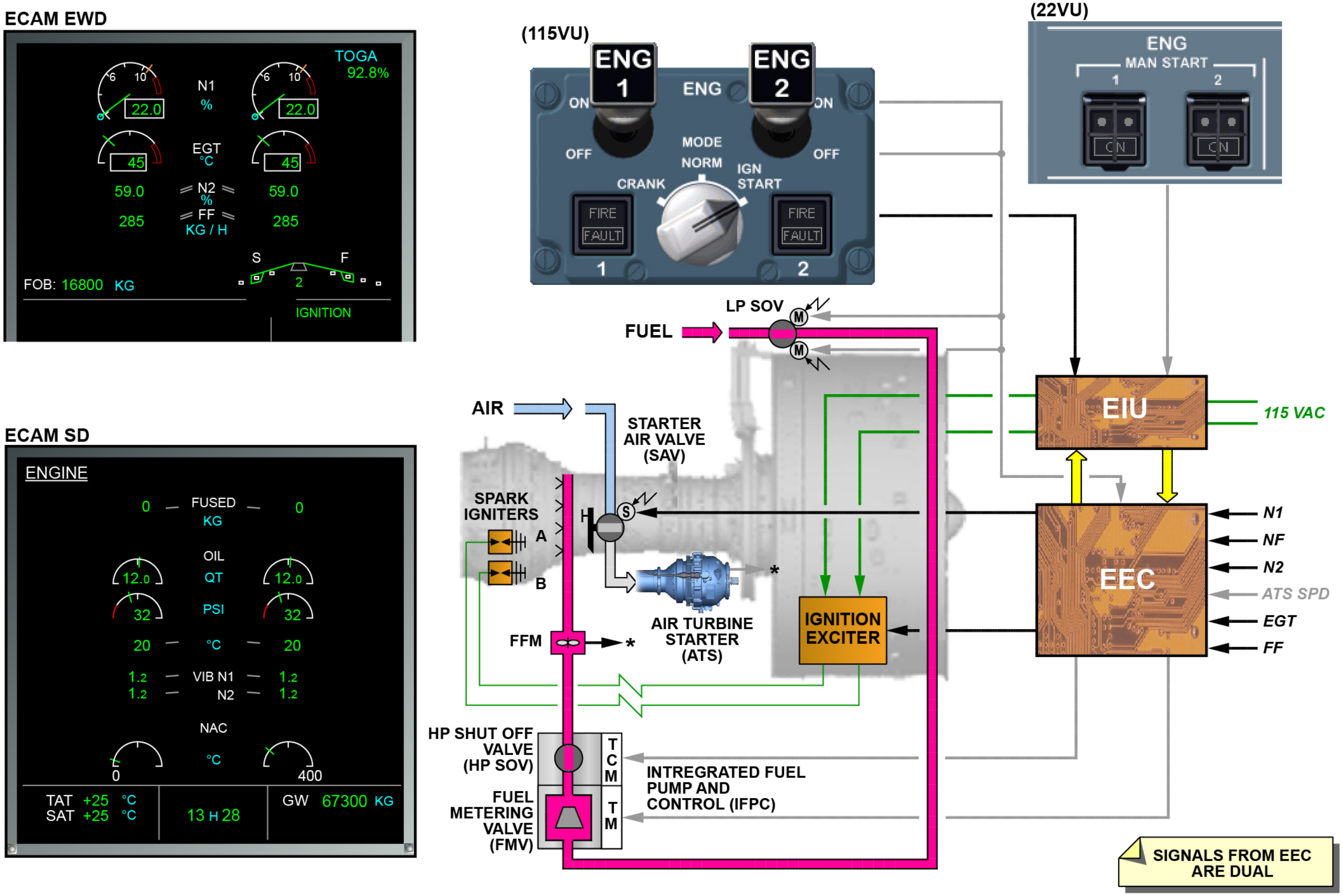
IGNITION & STARTING SYSTEM D/O (ME) (3)

CONTINUOUS IGNITION

Continuous ignition is manually selected or automatically controlled by the FADEC.
During continuous ignition both igniters are active.
Manual command:
Once the engine is running and above idle, the pilot can manually command continuous ignition at any time by moving the rotary selector to the IGN/START position.
Following a ground start, the rotary selector must be moved back to NORM before continuous ignition can be manually selected by moving it back to IGN/START position.
Continuous ignition shall remain commanded by the EEC until the rotary selector is moved back to NORM.
In the event that data position of the rotary selector sent by Engine Interface Unit (EIU) to EEC is not available or invalid, the EEC shall use the last valid value of the rotary selector position if the aircraft is on ground until a valid configuration is received again.
Automatic command:
The EEC automatically commands continuous ignition at the following conditions:
- If an engine flameout is detected in flight, or during takeoff, igniters are kept on for a minimum of 30 seconds after the engine has recovered from the flameout and reached idle,
- If a surge is detected in flight or during takeoff, igniters are powered until 30 seconds after the surge recovers,
- If the EEC detects a quick relight (Master Lever cycled from ON to OFF and back to ON in flight),
- If TCM Cutback is commanded.
Automatic continuous ignition shall be inhibited if the burner pressure (PB) is above 150 psi (the nominal deteriorated igniter quench point) to preserve igniter life.



CONTINUOUS IGNITION

IGNITION & STARTING SYSTEM D/O (ME) (3)

ENGINE CRANK

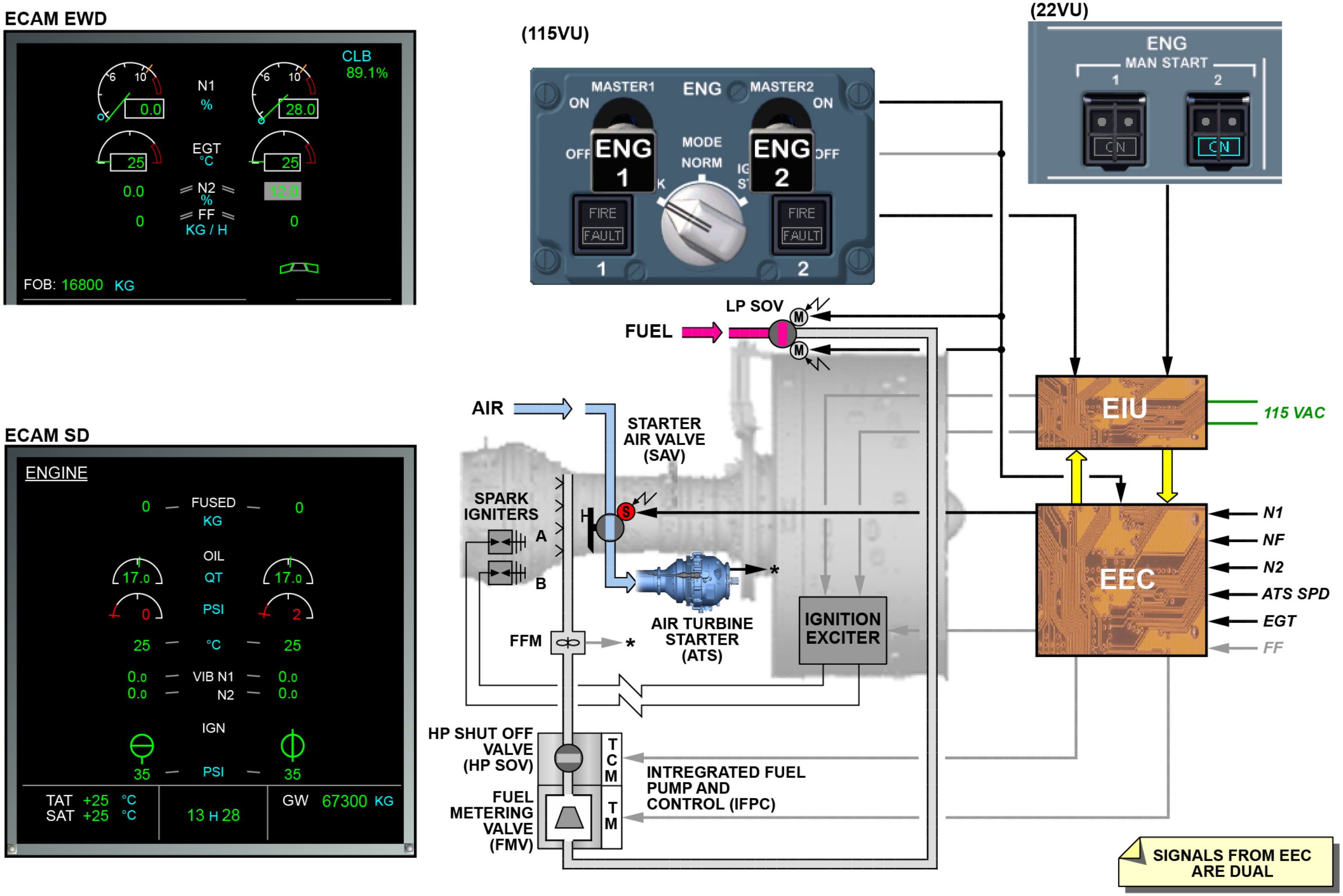
DRY CRANK

Cranking function is used to motor the engine on the ground for a short time with the use of the starter.
There are two cranking modes:
- dry cranking,
- wet cranking.

The dry cranking procedure is used to motor the engine to remove unburned fuel from the combustion chamber or cool down the engine or for some fuel or oil leak tests.
The EEC shall enter the engine dry crank sequence when all of the following conditions are true:
- the engine is not running and,
- the aircraft is on ground and,
- the rotary selector is set to CRANK.

This will power up the EEC and isolate both ignition systems.
The ENGINE page appears automatically on the ECAM SD.
When the ENG MAN START P/B is set to ON, the EEC commands the SAV to open.
The dry motoring can be interrupted at any time by pushing the ENG MAN START pushbutton to OFF or positioning the ENG MODE rotary selector to NORM position.
The usual starter duty cycle is 3 starter crank cycles or 4 minutes maximum of continuous cranking. A 30 minutes cool down period is necessary for additional use.

WARNING: the EEC is able to initiate a start sequence immediately following a dry motoring sequence by setting the ENG MODE rotary selector to IGN/START position and the ENG MASTER control lever to ON position.



ENGINE CRANK - DRY CRANK

UJ515241 - U08T0MEP - UM74D1PW1100G07

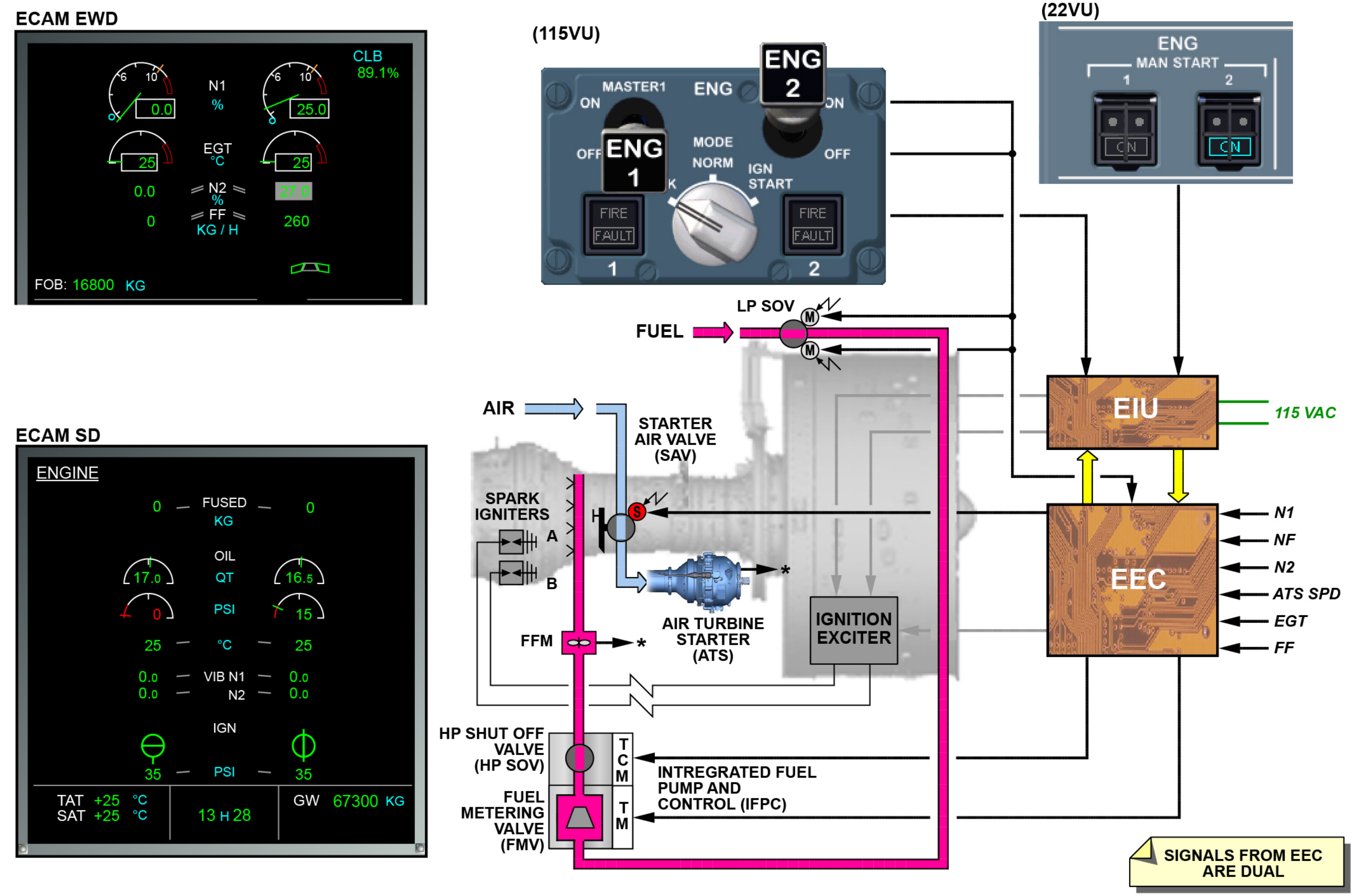
IGNITION & STARTING SYSTEM D/O (ME) (3)

ENGINE CRANK (continued)

WET CRANK

The wet cranking procedure is used to motor the engine for specific fuel or oil leak tests.
The fuel flow is commanded but both ignition systems are isolated.
The fuel goes through the IFPC to the actuator fuel pressure lines, the engine fuel manifolds (primary fuel lines only), and nozzles. Fuel is then sprayed in the combustion chamber.
The first steps of the wet crank sequence are the same as the ones for the dry crank:
- the engine is not running,
- the aircraft is on ground,
- the rotary selector is set to CRANK (EEC powered, both ignition systems isolated, ENGINE page appears),
- the ENG MAN START P/B is set to ON. (SAV opening).

When N2 speed stabilizes, the ENG MASTER lever is set to the ON position to command the fuel flow.
After 15 seconds, the ENG MASTER lever is set to the OFF position to cut the fuel supply.
The SAV command is maintained 30 seconds to blow all the fuel from the engine.
The wet motoring ends by pushing the ENG MAN START pushbutton to OFF or/and positioning the ENG MODE rotary selector to NORM position.

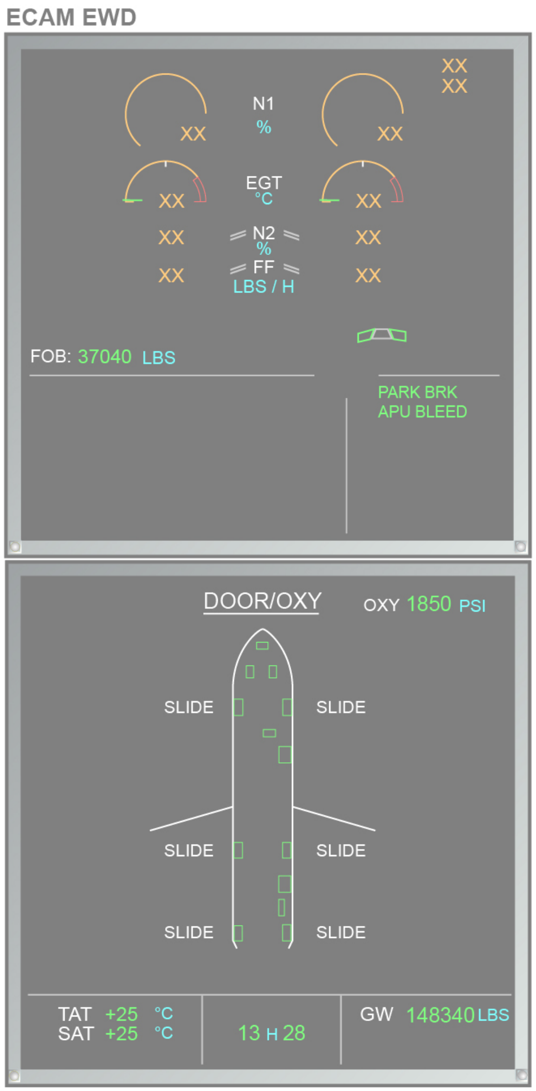


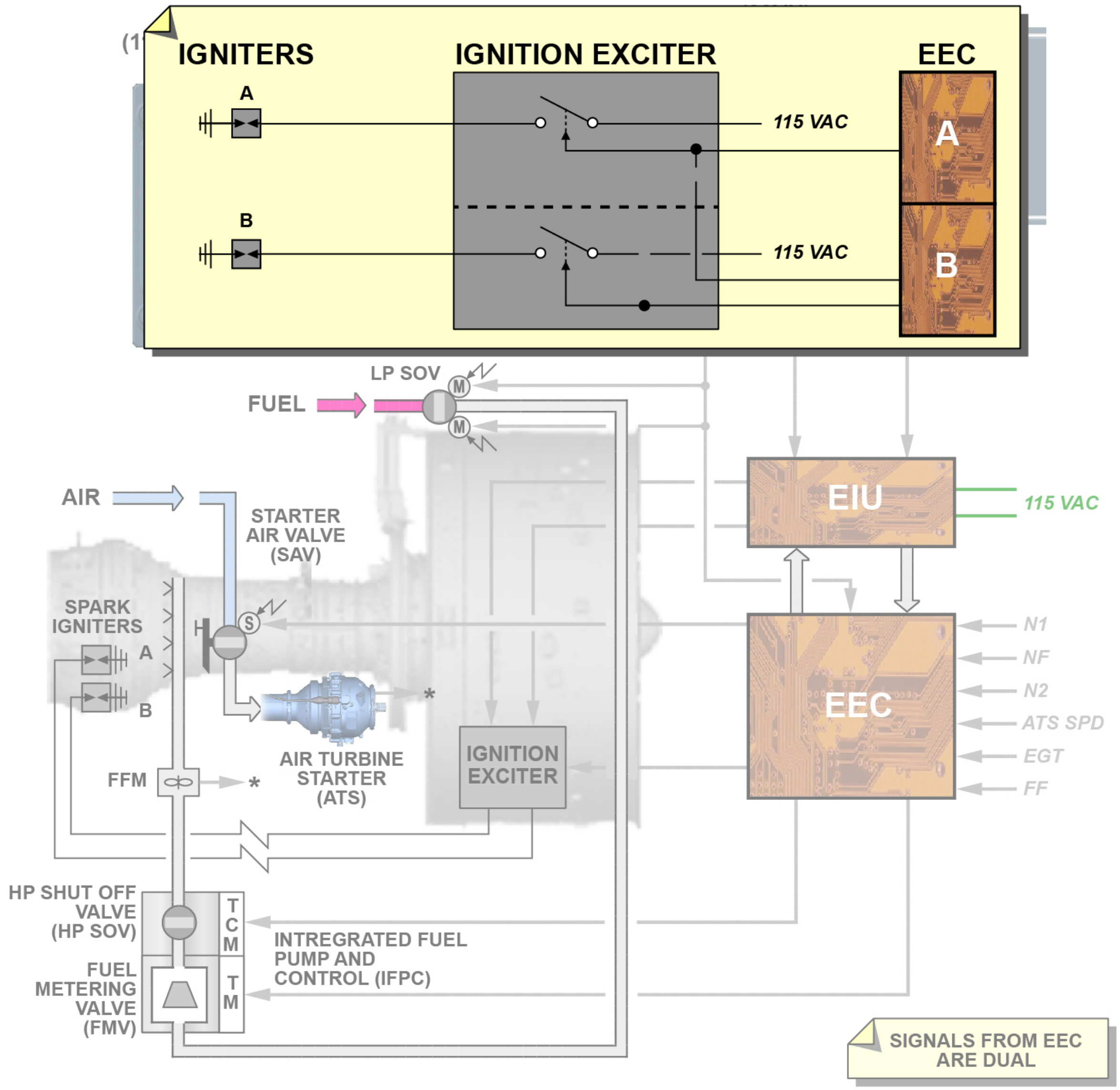
ENGINE CRANK - WET CRANK

IGNITION & STARTING SYSTEM D/O (US) (3)

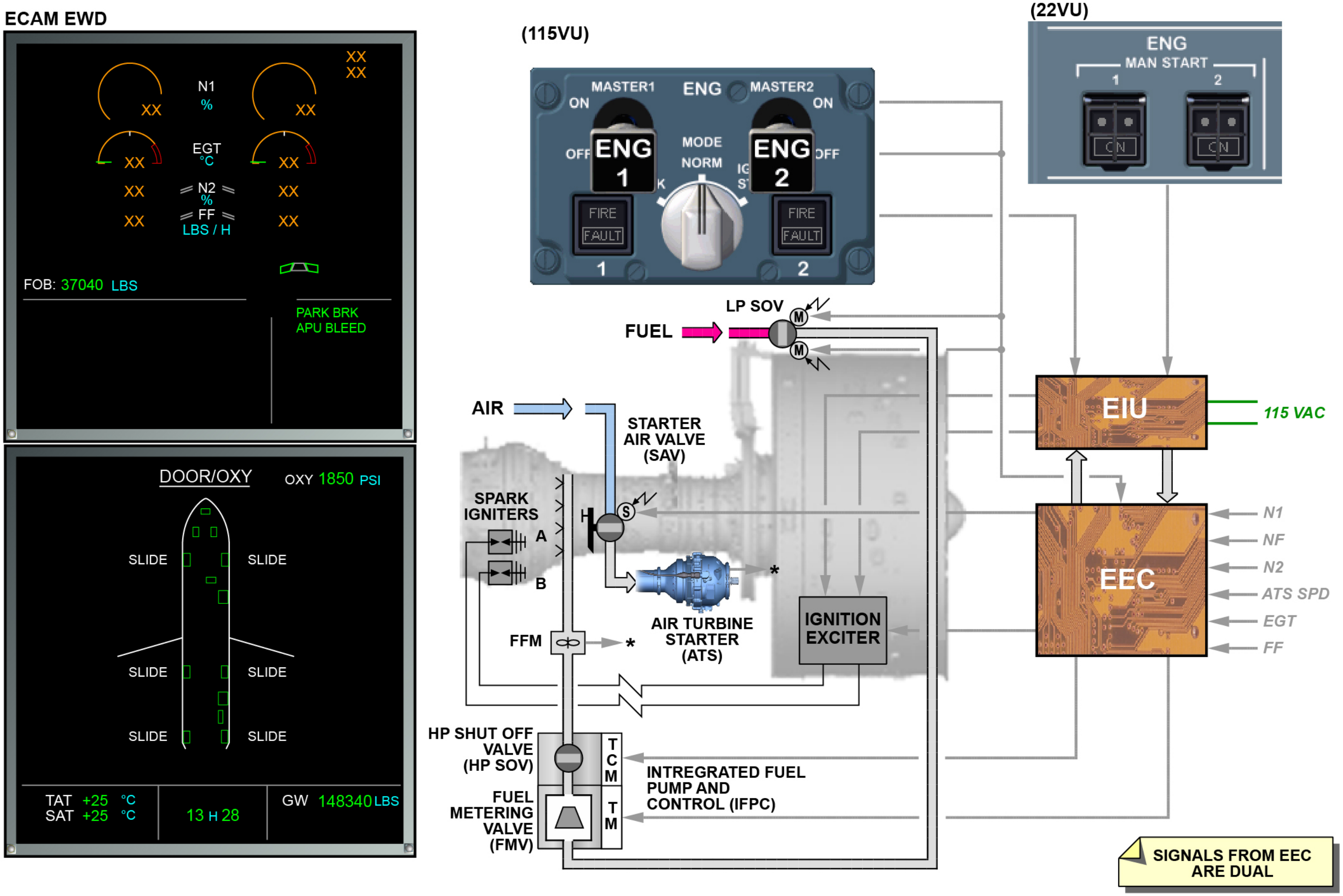
GENERAL

The Electronic Engine Control (EEC) controls and monitors the Starting and Ignition systems for engine starting, cranking, and ignition selection, on ground and in flight.
For engine starting, two modes are available; automatic or manual.
Both modes can be used on ground or in flight but in flight sequence are less protective to enhance the restart capability.
For engine cranking, two sequences can be manually selected: dry or wet.
The EEC controls the starting and ignition components according to cockpit commands and protective logics.
The main engine parameters to be monitored during starting are displays on the E/WD (N1, EGT, N2, Fuel Flow) and on the SD (Oil Press, IGN system, Starter Air Valve position and available pneumatic pressure).
The ignition system is composed of a dual channel ignition exciter supplying two spark igniter plugs.
Each plug and corresponding circuit (identified as system A and system B) can be used at the same time or alternately to detect dormant failures.
The EEC controls the ignition by providing command signals to the internal relays of the ignition exciter, whereas the EIU supplies 115 Volt power supply to the ignition exciter.
The starting system consists of a Starter Air Valve (SAV), air duct and an Air Turbine Starter (ATS).
The SAV is electrically controlled by the EEC and pneumatically operated.
The ATS is attached to the aft of the main gearbox at the 5 o'clock position. It is fitted with a speed sensor which is used for system control and monitoring by the EEC.
The pressurized air supply to the starting components is provided by one of the following sources:
- Auxiliary Power Unit (APU) bleed,
- external pneumatic ground cart,
- engine bleed from the opposite engine.


ECAM EWD
N1
%
XX
XX
XX
EGT
°C
XX
N2
%
FF
LBS / H
FOB: 37040 LBS
PARK BRK
APU BLEED
DOOR/OXY
OXY 1850 PSI
SLIDE
SLIDE
SLIDE
SLIDE
SLIDE
SLIDE
TAT +25 °C
SAT +25 °C
13 H 28
GW 148340 LBS


IGNITERS
IGNITION EXCITER
EEC
A
B
115 VAC
115 VAC
A
B
LP SOV
FUEL
M
M
AIR
STARTER AIR VALVE (SAV)
EIU
115 VAC
SPARK IGNITERS
A
B
S
AIR TURBINE STARTER (ATS)
IGNITION EXCITER
EEC
N1
NF
N2
ATS SPD
EGT
FF
FFM
*
HP SHUT OFF VALVE (HP SOV)
FUEL METERING VALVE (FMV)
TCM
TM
INTREGRATED FUEL PUMP AND CONTROL (IFPC)
SIGNALS FROM EEC ARE DUAL

GENERAL


ECAM EWD
N1
%
XX
EGT
°C
N2
%
FF
LBS / H
FOB: 37040 LBS
PARK BRK
APU BLEED
DOOR/OXY
OXY 1850 PSI
SLIDE
TAT +25 °C
SAT +25 °C
13 H 28
GW 148340 LBS
(115VU)
MASTER1
ENG
MASTER2
ON
OFF
ENG 1
ENG 2
MODE
NORM
FIRE
FAULT
1
2
(22VU)
ENG
MAN START
ON
LP SOV
FUEL
AIR
STARTER
AIR VALVE
(SAV)
SPARK
IGNITERS
A
B
FFM
AIR TURBINE
STARTER
(ATS)
IGNITION
EXCITER
HP SHUT OFF
VALVE
(HP SOV)
FUEL
METERING
VALVE
(FMV)
TCM
TM
INTREGRATED FUEL
PUMP AND
CONTROL (IFPC)
EIU
EEC
115 VAC
N1
NF
N2
ATS SPD
EGT
FF
SIGNALS FROM EEC
ARE DUAL

GENERAL

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IGNITION & STARTING SYSTEM D/O (US) (3)

AUTOMATIC START

The EEC shall enter the automatic start mode when all of the following conditions are true:
- the engine is not running, and
- the selected rotary selector is set to IGN/START, and
- the selected ENG MASTER lever is set to ON, and
- the ENG MAN START pushbutton is OFF.

When the ENG MODE rotary selector is set to IGN/START position, FADEC is powered up.
The ENGINE page is automatically shown on the System Display (SD) page of the ECAM system.
The ENGINE page displays the IGN indication, SAV position and bleed pressure during this sequence.
At the same time, the APU bleed demand will increase and the pack valves will close.
As soon as the ENG MASTER lever is set to ON position, the LPSOV opens and the automatic starting sequence begins.
The EEC will automatically control the:
- Thrust Control Malfunction (TCM) cutback test,
- HPC active bleed valve (opening and closing),
- Hydraulic pump depressurizing (via EIU) if necessary during in flight restart,
- SAV (opening and closing),
- Igniters (one or two, on and off),
- Fuel Flow (FMV and HPSOV opening).

First, the EEC energizes the SAV solenoid. This supplies the starter with aircraft pneumatic pressure.
The position of the SAV is confirmed open at the bottom of the ENGINE page thanks to the ATS speed sensor feedback.
Consequently, the N2 begins to increase.
When the engine reaches the minimum fuel pressurization speed (18% N2), the EEC activates one igniter and controls the appropriate fuel flow to the burner.
On the SD ENGINE page, the corresponding spark igniter system (A or B) controlled by the EEC comes into view.
On the E/WD, the FF increases.
Fuel is sent to the burner via the Fuel Metering Valve (FMV) and the High Pressure Shut Off Valve (HPSOV) in the Integrated Fuel Pump and Control (IFPC).
The EEC monitors the Exhaust Gas Temperature (EGT) and N2 according to their schedules to provide the correct fuel flow for a good acceleration.
When N2 reaches 51% N2, the automatic start sequence ends when the EEC controls the SAV to close and the igniter to OFF.
The engine continues to accelerate and stabilizes at idle speed.
The usual standard parameters are:
- N1 = 19%,
- N2 = 58%,
- EGT = 440 °C,
- FF = 500 lbs/h.

If the second engine has to be started, the ENG MODE rotary selector should stay on the IGN/START position.
This will avoid activating the continuous ignition on the running engine if the selector is cycled to NORM and again to IGN/START.
When both engines are running, the selector is set back to NORM, the WHEEL page will appear instead of the ENGINE page if at least one engine running.
Automatic start abort:
The EEC has the authority to abort a start only on the ground.
The EEC will abort the start, dry motor the engine for 30 seconds and attempt a single start for the following reasons:
- no light up (EGT low and constant),
- no N2 acceleration (hung start),
- EGT reaches starting limit (impending hot start).

NOTE: The maximum EGT during start sequence is 700º C.

The EEC will abort a start, dry motor the engine for 30 seconds and not attempt a restart for the following conditions:

- Failure of automatic restart,
- N1 locked rotor,
- EEC unable to command both igniters,
- Loss of EGT indication (T5 sensors failed),
- EEC unable to control fuel flow.

The EEC will also abort a start, will not dry motor the engine and will not attempt a restart if the starter duty cycle is exceeded.

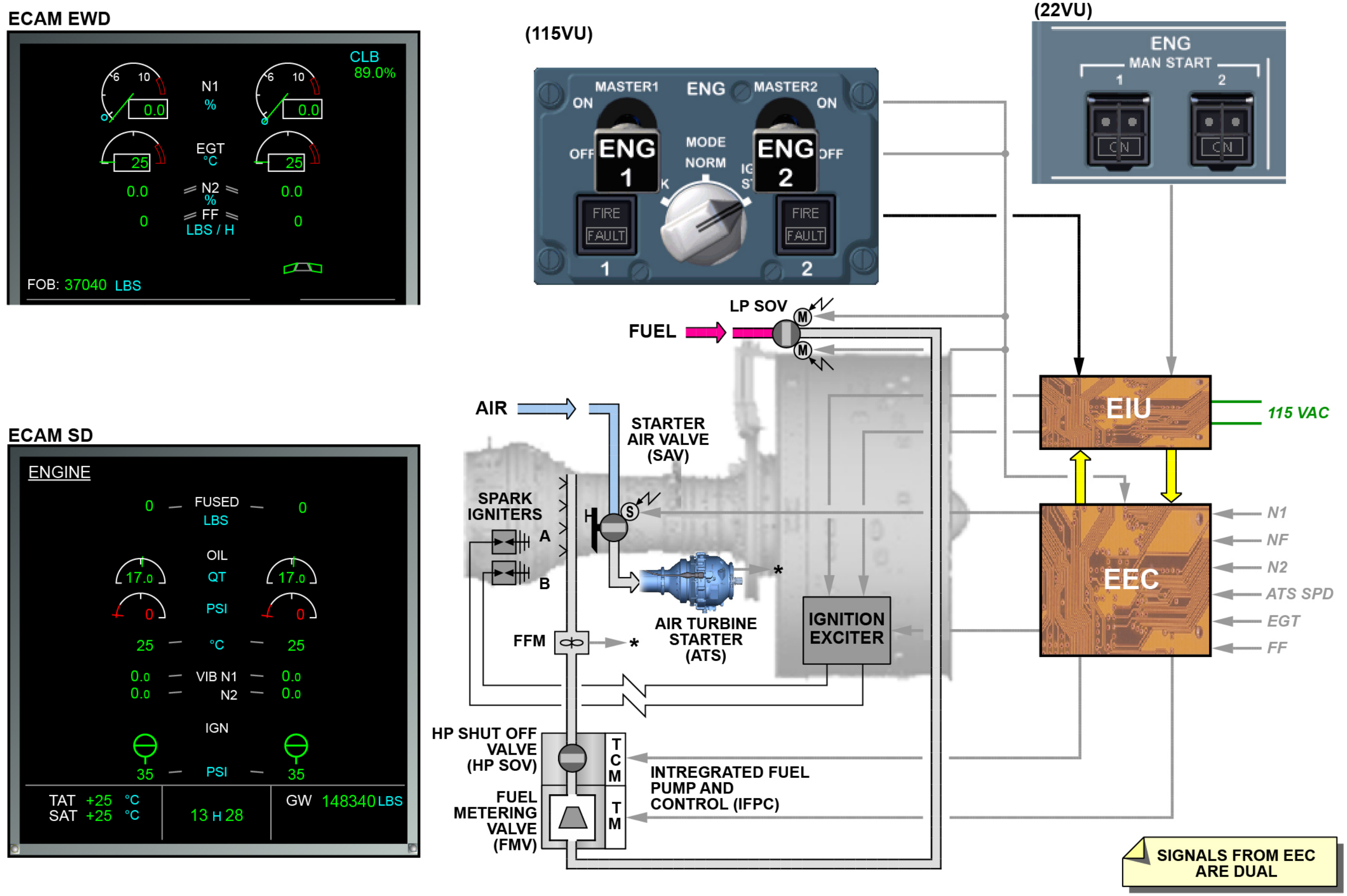
Manual start abort:

The automatic start sequence can be manually aborted by selection of the ENG MASTER lever to OFF position.

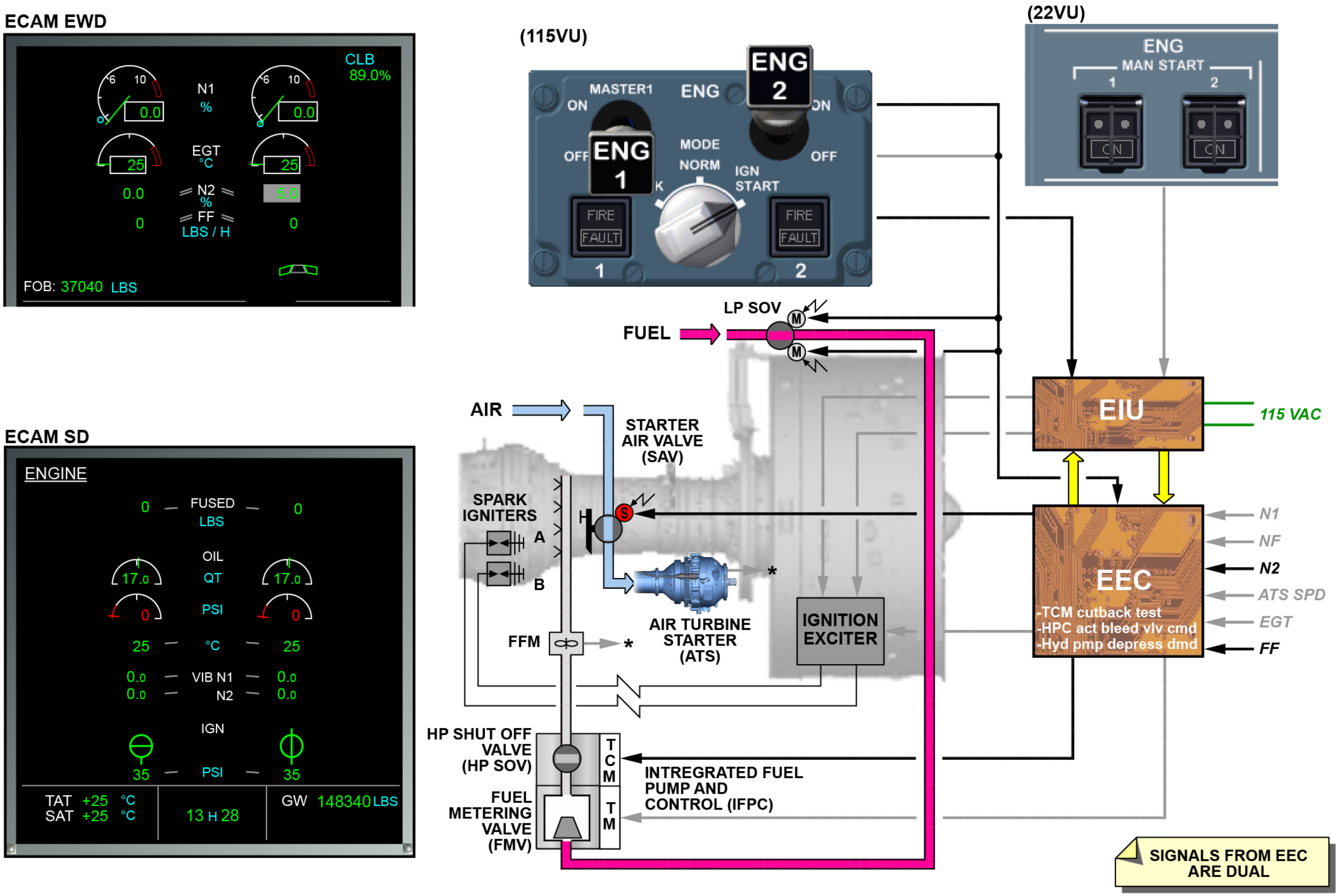
This leads to:

- SAV closure,
- Igniter(s) off,
- FMV, LP and HP fuel shut-off valves closure.

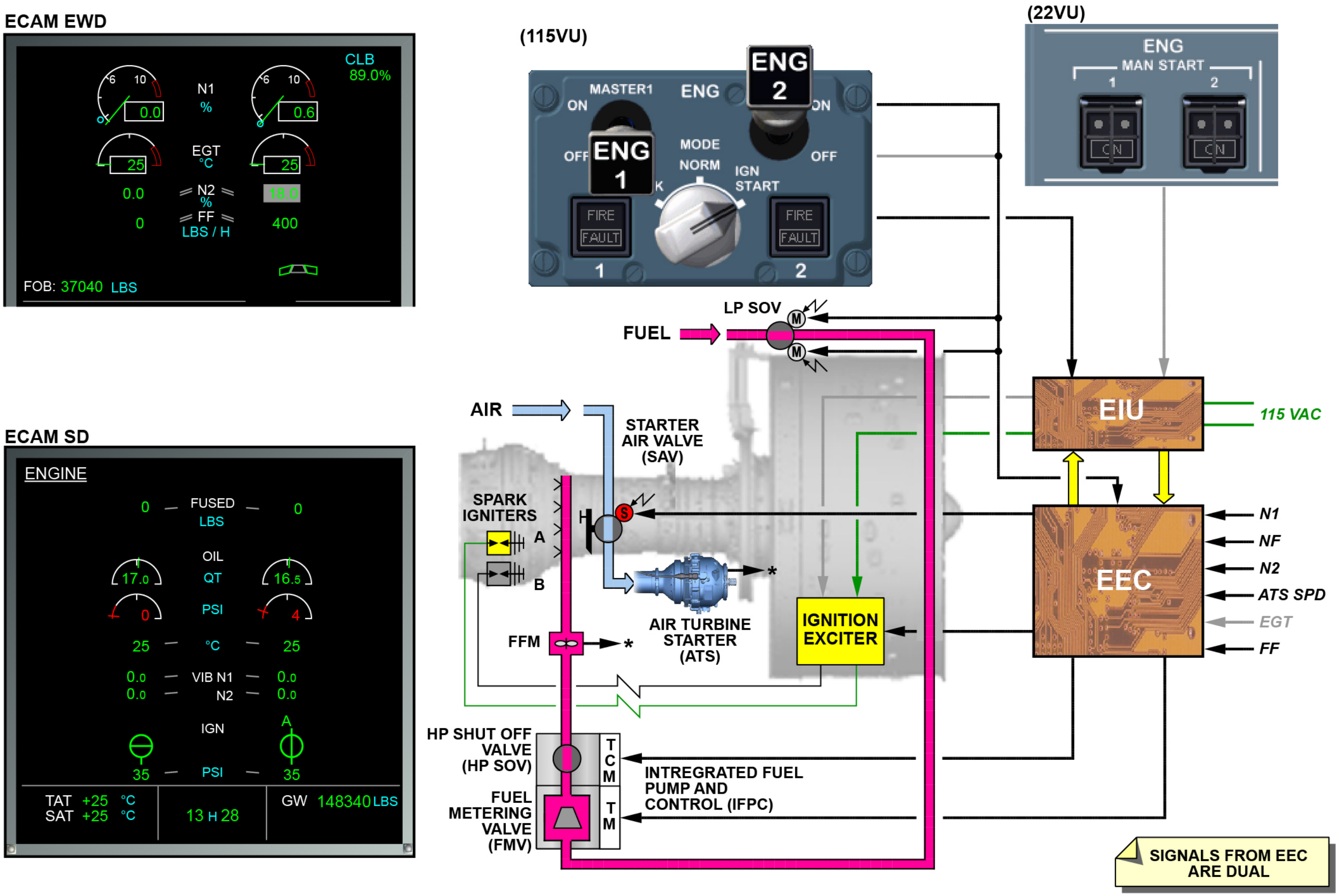
NOTE: EEC does not dry motor the engine when an automatic start is manually aborted.



AUTOMATIC START

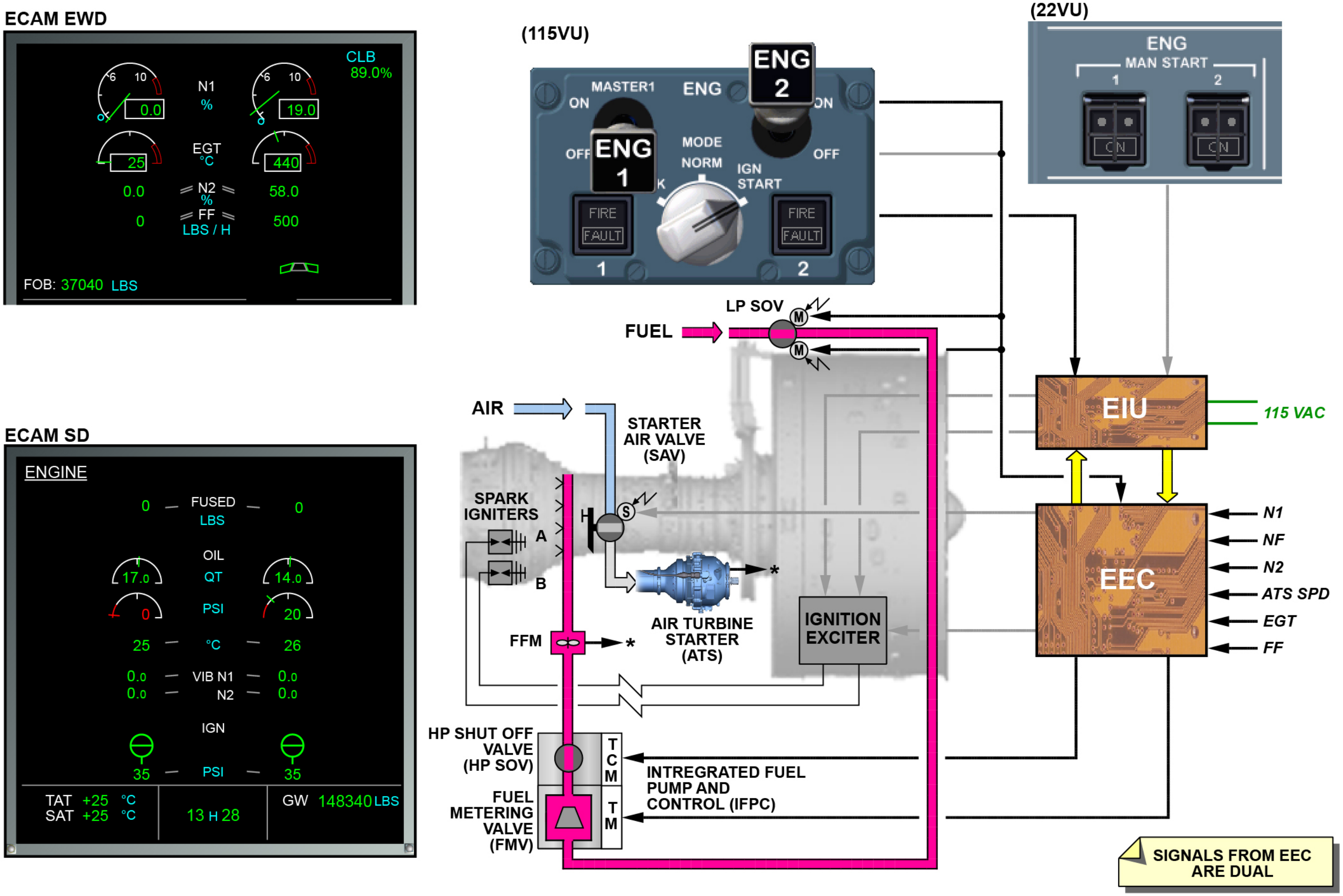


AUTOMATIC START



AUTOMATIC START

UJ515241 - U08T0MEP - UM74D1PW1100G06

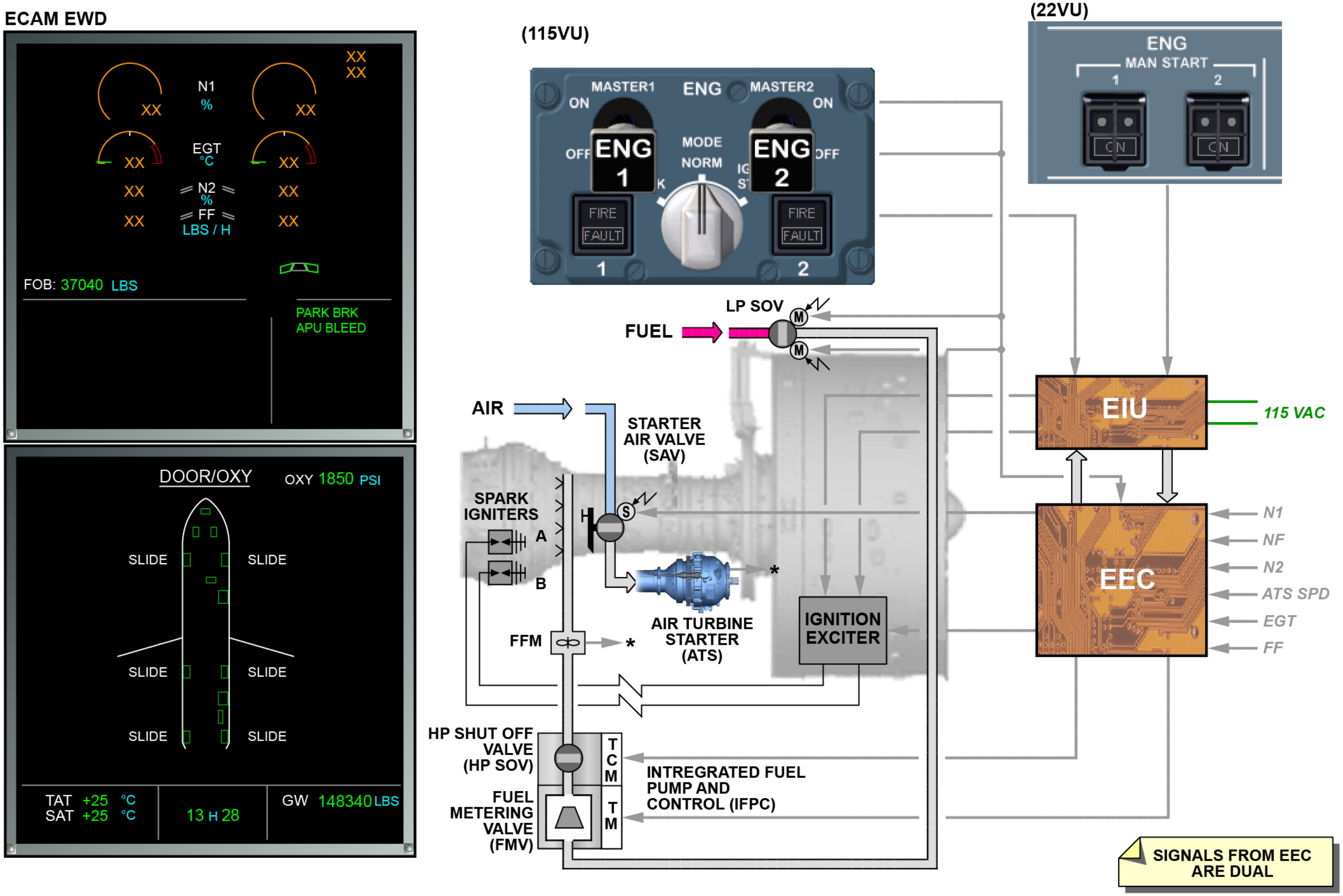


AUTOMATIC START

IGNITION & STARTING SYSTEM D/O (US) (3)

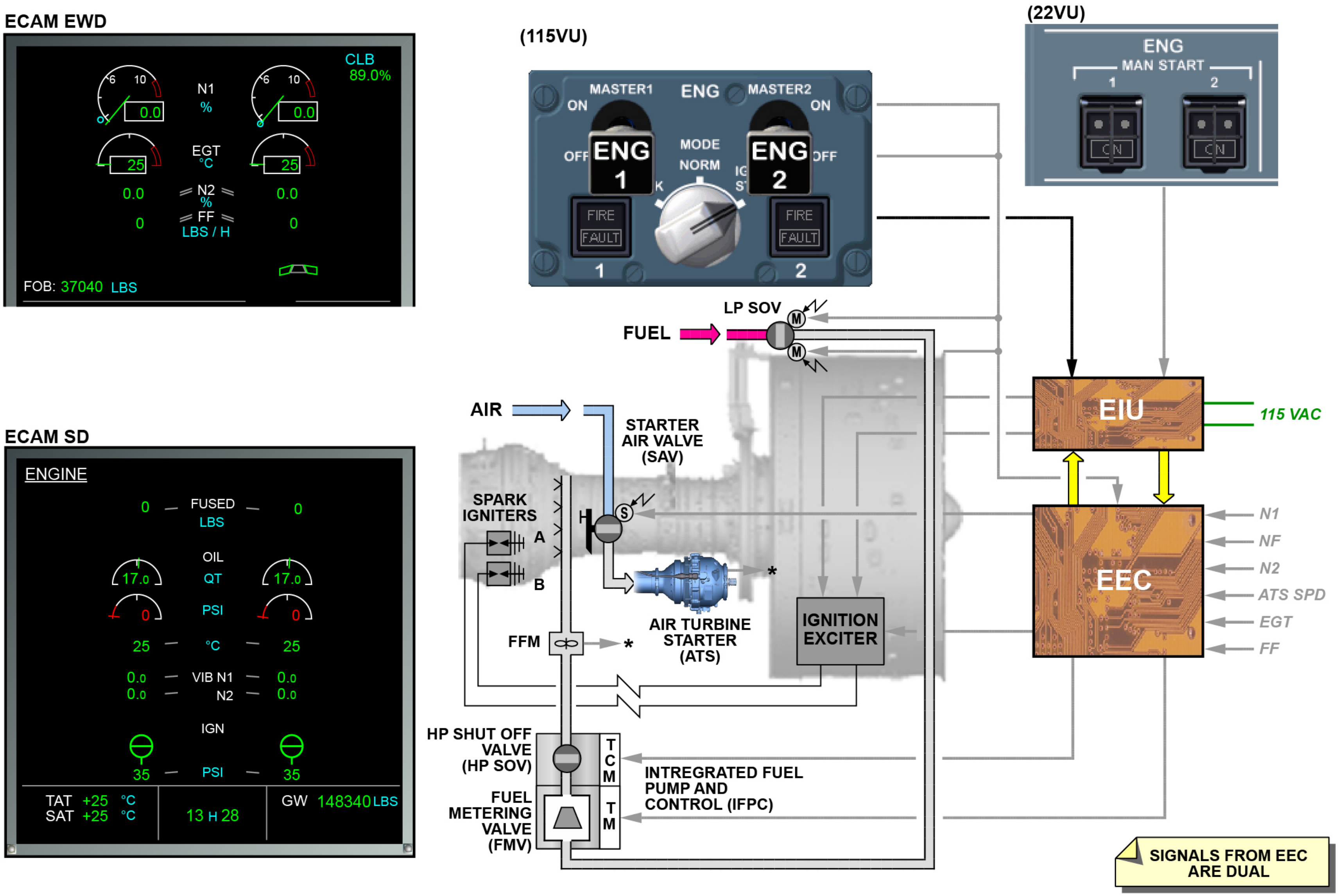
MANUAL START

A manual engine start procedure is included in the EEC engine starting logic.
In the manual start mode, engine starting control is under limited authority of the EEC.
The SAV, fuel, and ignition are controlled from the cockpit via the EEC.
Bleed air source being available, a manual start sequence is commanded by first setting the rotary selector to the IGN/START position to power and signal the EEC.
The ENGINE page appears on the SD page of the ECAM.
The ENGINE page displays the IGN indication, SAV position and bleed pressure during this sequence.
At the same time, the APU bleed demand will increase and the pack valves will close.
The next action is to engage the ENG MAN START push-button to the ON position. This will lead the EEC to open the SAV.
When N2 is above the minimum fuel pressurization speed (on-ground approximately 18% N2), the ENG MASTER lever is set to the ON position. The EEC commands fuel flow and both igniters simultaneously.
The EEC monitors the EGT and N2 according to their schedules to provide the correct fuel flow but EGT limit protection is inactive.
When N2 reaches 51% N2, the manual start sequence automatically ends when the EEC controls the SAV to close and the igniters to OFF.
The engine continues to accelerate and stabilizes at idle speed.
Manual start abort:
When a manual engine start has been initiated on ground or in flight, it shall be interrupted by either:
- de-selecting the ENG MAN START push-button before the ENG MASTER lever is commanded ON, or
- selecting ENG MASTER lever back to OFF position after it has already been selected ON.
Interruption of a manual start shall result in the following EEC commands:
- SAV closure,
- igniters off,
- FMV and HP fuel shut-off valve closure.

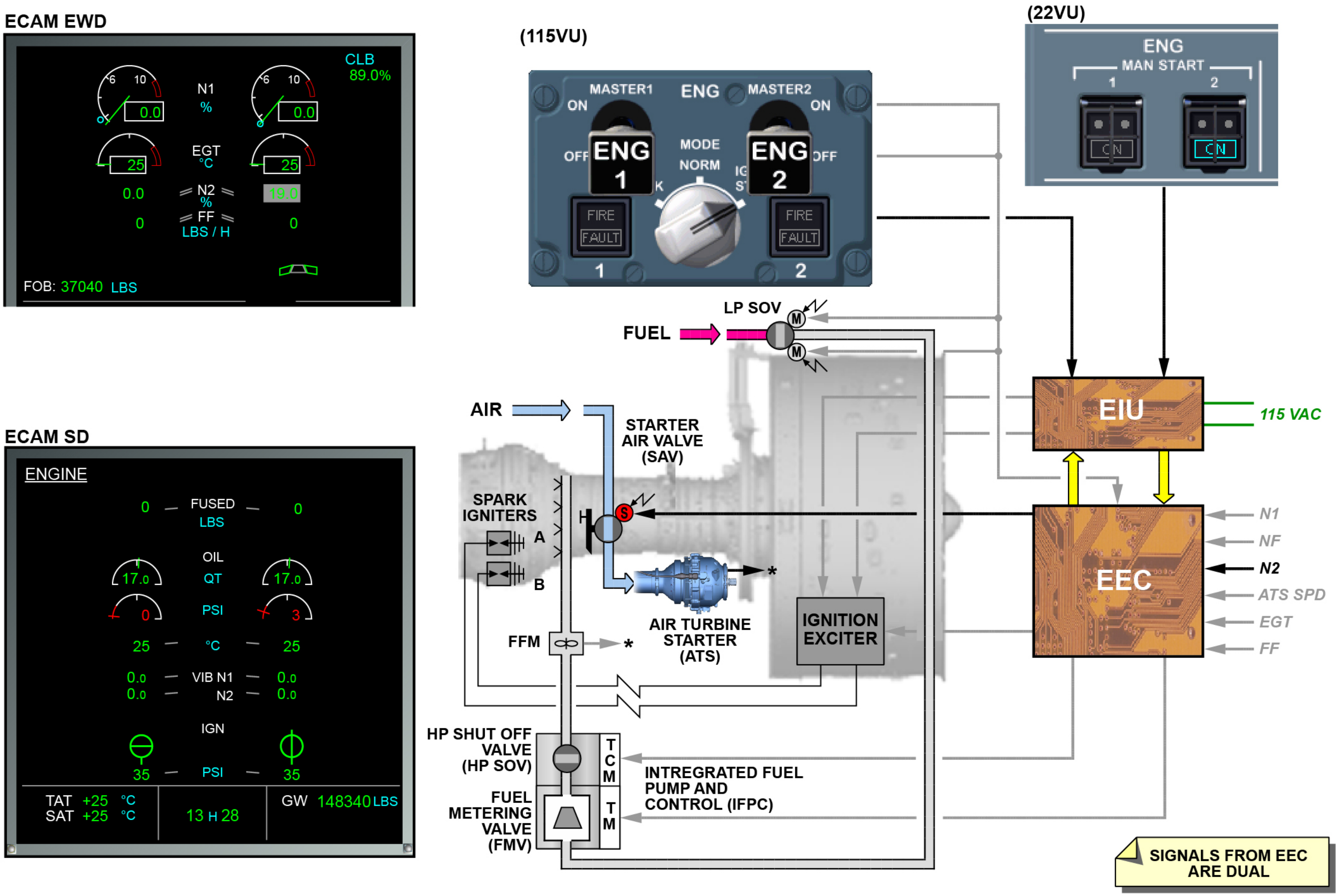


MANUAL START

UJ515241 - U08T0MEP - UM74D1PW1100G06

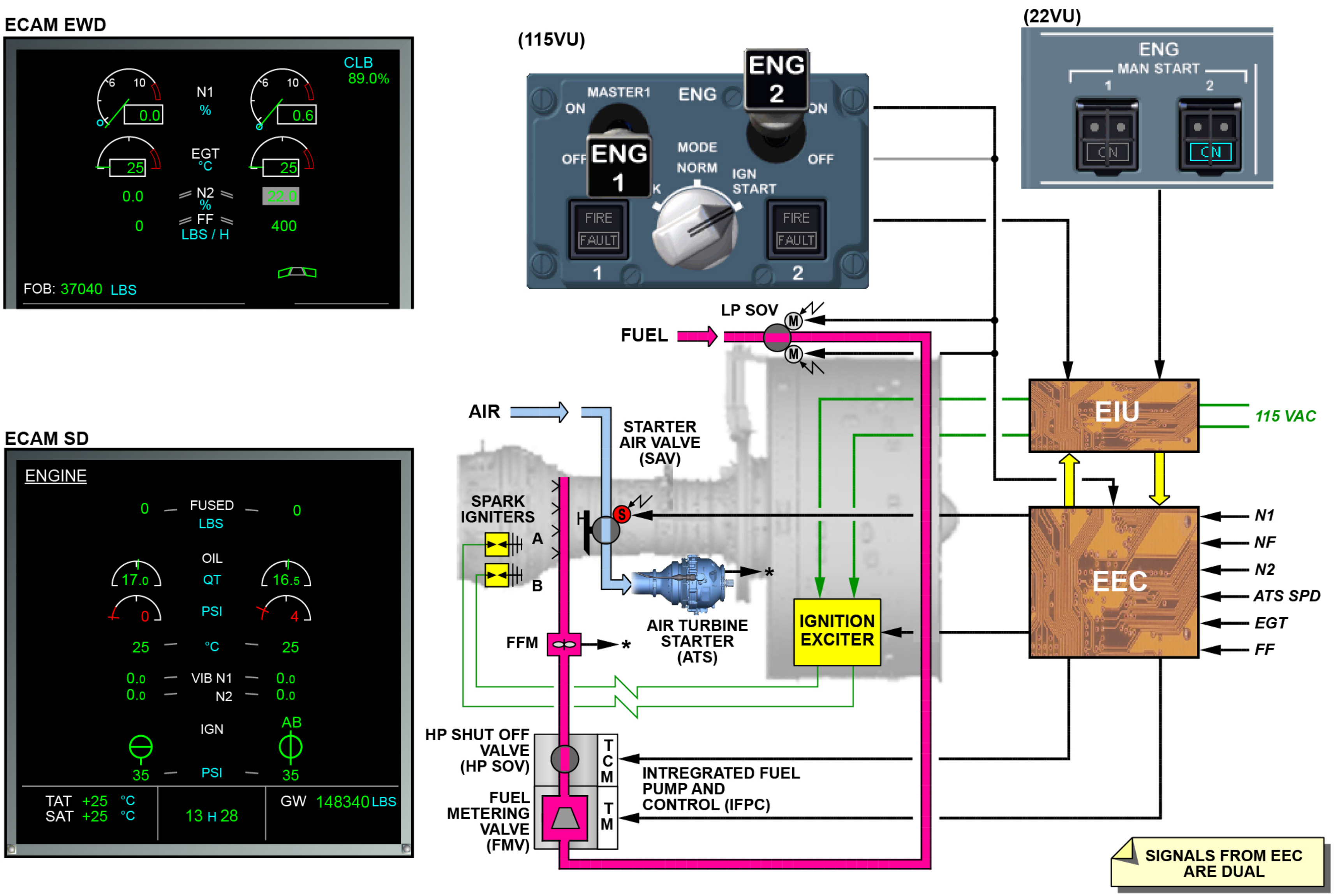


MANUAL START



MANUAL START

UJ515241 - U08T0MEP - UM74D1PW1100G06



MANUAL START

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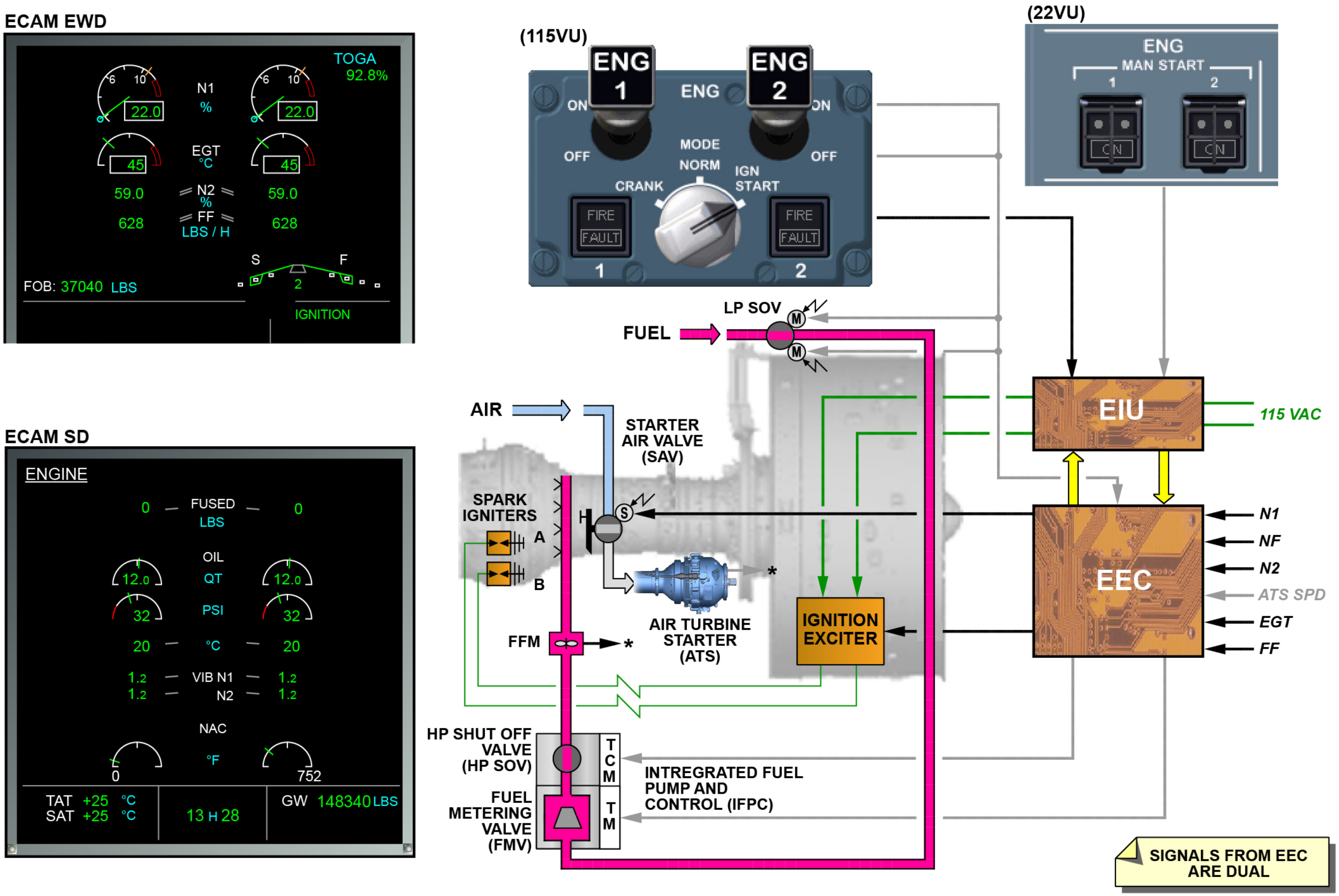
IGNITION & STARTING SYSTEM D/O (US) (3)

CONTINUOUS IGNITION

Continuous ignition is manually selected or automatically controlled by the FADEC.
During continuous ignition both igniters are active.
Manual command:
Once the engine is running and above idle, the pilot can manually command continuous ignition at any time by moving the rotary selector to the IGN/START position.
Following a ground start, the rotary selector must be moved back to NORM before continuous ignition can be manually selected by moving it back to IGN/START position.
Continuous ignition shall remain commanded by the EEC until the rotary selector is moved back to NORM.
In the event that data position of the rotary selector sent by Engine Interface Unit (EIU) to EEC is not available or invalid, the EEC shall use the last valid value of the rotary selector position if the aircraft is on ground until a valid configuration is received again.
Automatic command:
The EEC automatically commands continuous ignition at the following conditions:
- If an engine flameout is detected in flight, or during takeoff, igniters are kept on for a minimum of 30 seconds after the engine has recovered from the flameout and reached idle,
- If a surge is detected in flight or during takeoff, igniters are powered until 30 seconds after the surge recovers,
- If the EEC detects a quick relight (Master Lever cycled from ON to OFF and back to ON in flight),
- If TCM Cutback is commanded.
Automatic continuous ignition shall be inhibited if the burner pressure (PB) is above 150 psi (the nominal deteriorated igniter quench point) to preserve igniter life.



CONTINUOUS IGNITION

IGNITION & STARTING SYSTEM D/O (US) (3)

ENGINE CRANK

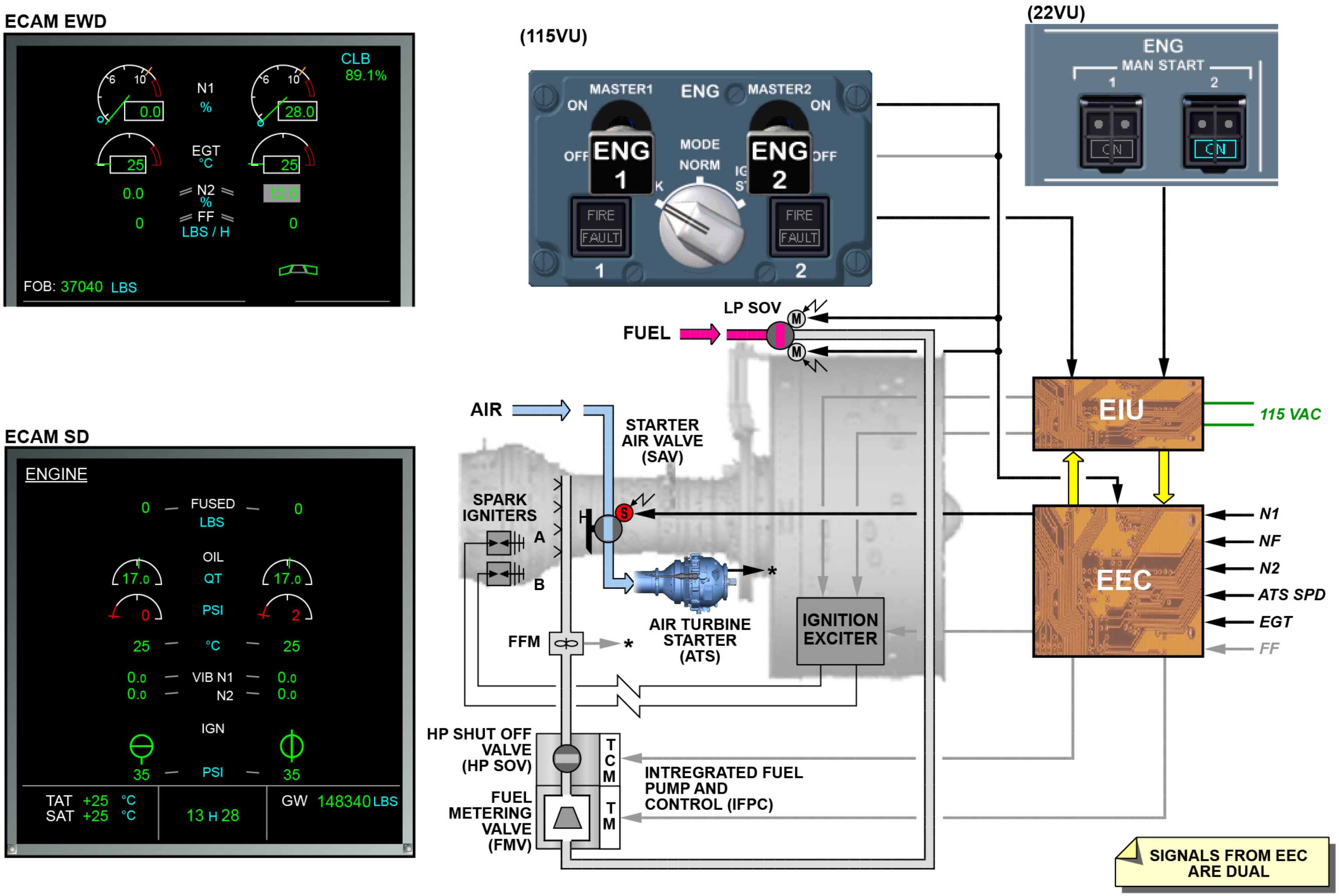
DRY CRANK

Cranking function is used to motor the engine on the ground for a short time with the use of the starter.
There are two cranking modes:
- dry cranking,
- wet cranking.

The dry cranking procedure is used to motor the engine to remove unburned fuel from the combustion chamber or cool down the engine or for some fuel or oil leak tests.
The EEC shall enter the engine dry crank sequence when all of the following conditions are true:
- the engine is not running and,
- the aircraft is on ground and,
- the rotary selector is set to CRANK.

This will power up the EEC and isolate both ignition systems.
The ENGINE page appears automatically on the ECAM SD.
When the ENG MAN START P/B is set to ON, the EEC commands the SAV to open.
The dry motoring can be interrupted at any time by pushing the ENG MAN START pushbutton to OFF or positioning the ENG MODE rotary selector to NORM position.
The usual starter duty cycle is 3 starter crank cycles or 4 minutes maximum of continuous cranking. A 30 minutes cool down period is necessary for additional use.

WARNING: the EEC is able to initiate a start sequence immediately following a dry motoring sequence by setting the ENG MODE rotary selector to IGN/START position and the ENG MASTER control lever to ON position.



ENGINE CRANK - DRY CRANK

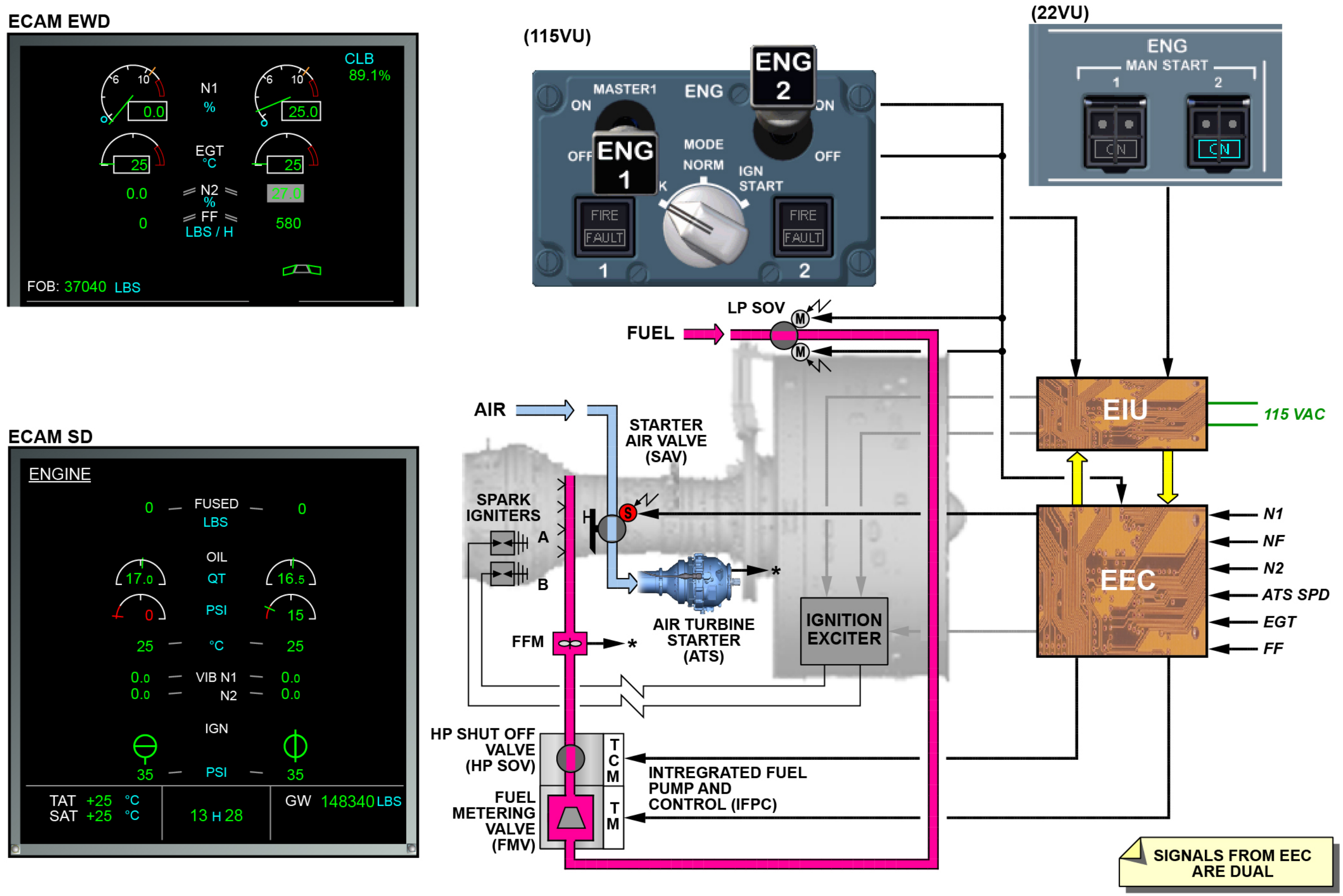
IGNITION & STARTING SYSTEM D/O (US) (3)

ENGINE CRANK (continued)

WET CRANK

The wet cranking procedure is used to motor the engine for specific fuel or oil leak tests.
The fuel flow is commanded but both ignition systems are isolated.
The fuel goes through the IFPC to the actuator fuel pressure lines, the engine fuel manifolds (primary fuel lines only), and nozzles. Fuel is then sprayed in the combustion chamber.
The first steps of the wet crank sequence are the same as the ones for the dry crank:
- the engine is not running,
- the aircraft is on ground,
- the rotary selector is set to CRANK (EEC powered, both ignition systems isolated, ENGINE page appears),
- the ENG MAN START P/B is set to ON. (SAV opening).

When N2 speed stabilizes, the ENG MASTER lever is set to the ON position to command the fuel flow.
After 15 seconds, the ENG MASTER lever is set to the OFF position to cut the fuel supply.
The SAV command is maintained 30 seconds to blow all the fuel from the engine.
The wet motoring ends by pushing the ENG MAN START pushbutton to OFF or/and positioning the ENG MODE rotary selector to NORM position.



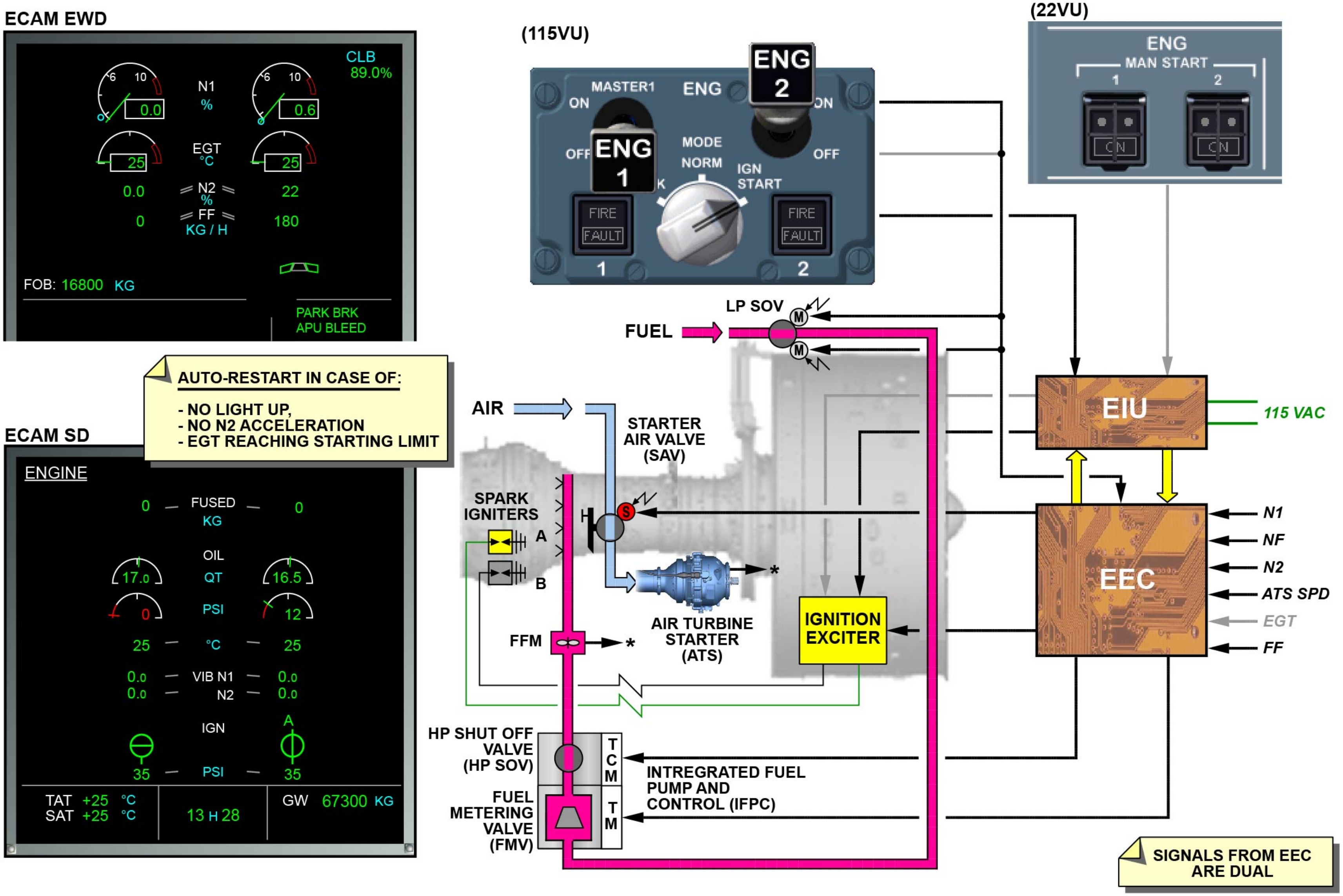
ENGINE CRANK - WET CRANK

UJ515241 - U08T0MEP - UM74D1PW1100G06

START FAILURES (ME) (3)

AUTO-RESTART

The Electronic Engine Computer (EEC) will abort the automatic start, dry motor the engine for 30 seconds and attempt a single auto-restart for the following reasons:
- No light up (Exhaust Gas Temperature (EGT) low and constant),
- No N2 acceleration (hung start),
- EGT reaches starting limit (impending hot start or surge).



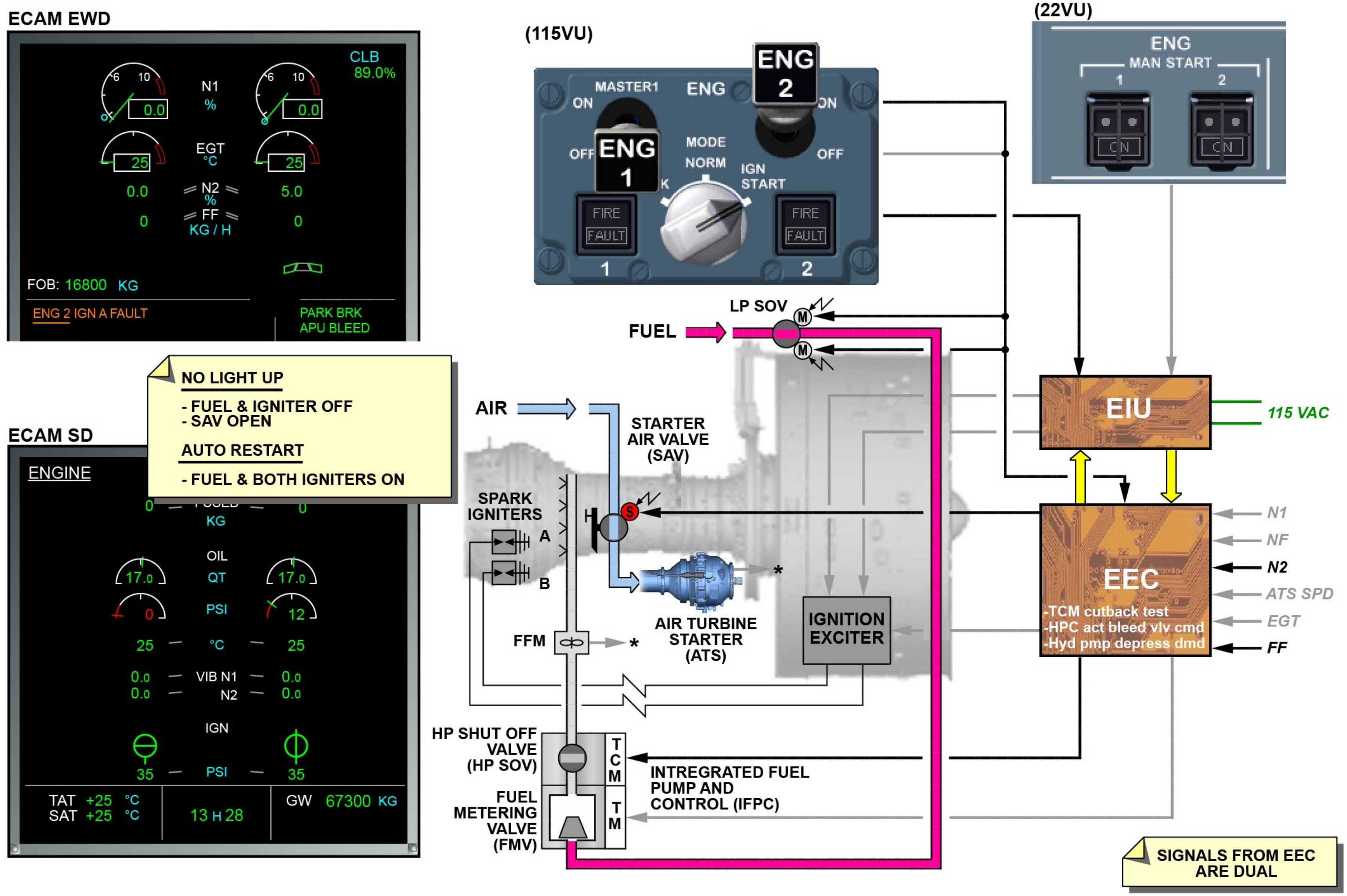
AUTO-RESTART

START FAILURES (ME) (3)

NO LIGHT UP

If during an automatic start, the EEC identifies a low EGT:
- It shuts down the fuel supply and the selected igniter,
- It generates the ECAM alert "ENG x IGN A(B) FAULT",
- It maintains the Starter Air Valve (SAV) open to clear fuel vapors and cool the turbine for 30 seconds,
- Then it controls simultaneously the fuel flow and both igniters,
- When N2 reaches the starter cutout speed (or the light up is confirmed), it switches the igniters off and controls the SAV closure 1 seconds after (or 1 seconds after the starter duty cycle is exceeded).

The engine continues to accelerate and stabilizes at idle speed.
If this auto-restart attempt fails, the start is aborted and the EEC will generate the ECAM alerts "ENG x START FAULT (IGNITION FAULT)" and "ENG x IGN A+B FAULT".



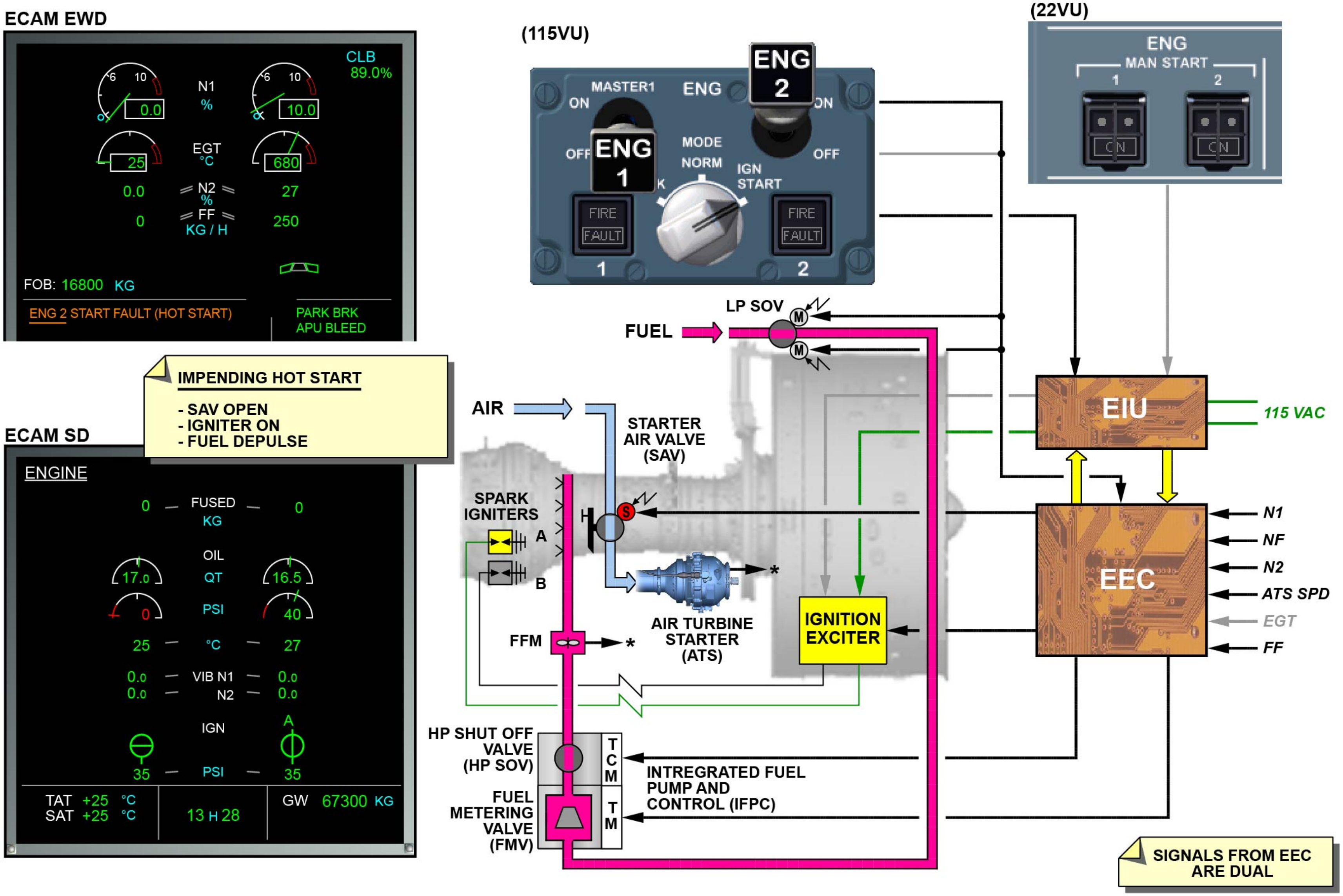
NO LIGHT UP

UJ515241 - U08T0MEP - UM74D2PW1100G07

START FAILURES (ME) (3)

IMPENDING HOT START

If during an automatic start, the EEC identifies an impending hot start, it maintains the SAV open, the selected igniter on and controls a fuel depulse procedure: it cycles fuel off for 2 seconds and back on for 12 seconds via the Fuel Metering Valve (FMV) for a maximum of 28 seconds to lower EGT below the limit. The EEC will generate the ECAM alert "ENG x START FAULT (HOT START)".
If the fault disappears, the starting sequence goes on normally up to the engine stabilizes at idle speed.
If the fault is still present, the EEC shuts down the fuel supply and the igniter, performs a dry motor for 30 seconds and attempts a single auto-restart.
If this auto-restart attempt fails, the start is aborted and the EEC will generate the ECAM alert "ENG x START FAULT (EGT OVERLIMIT)"



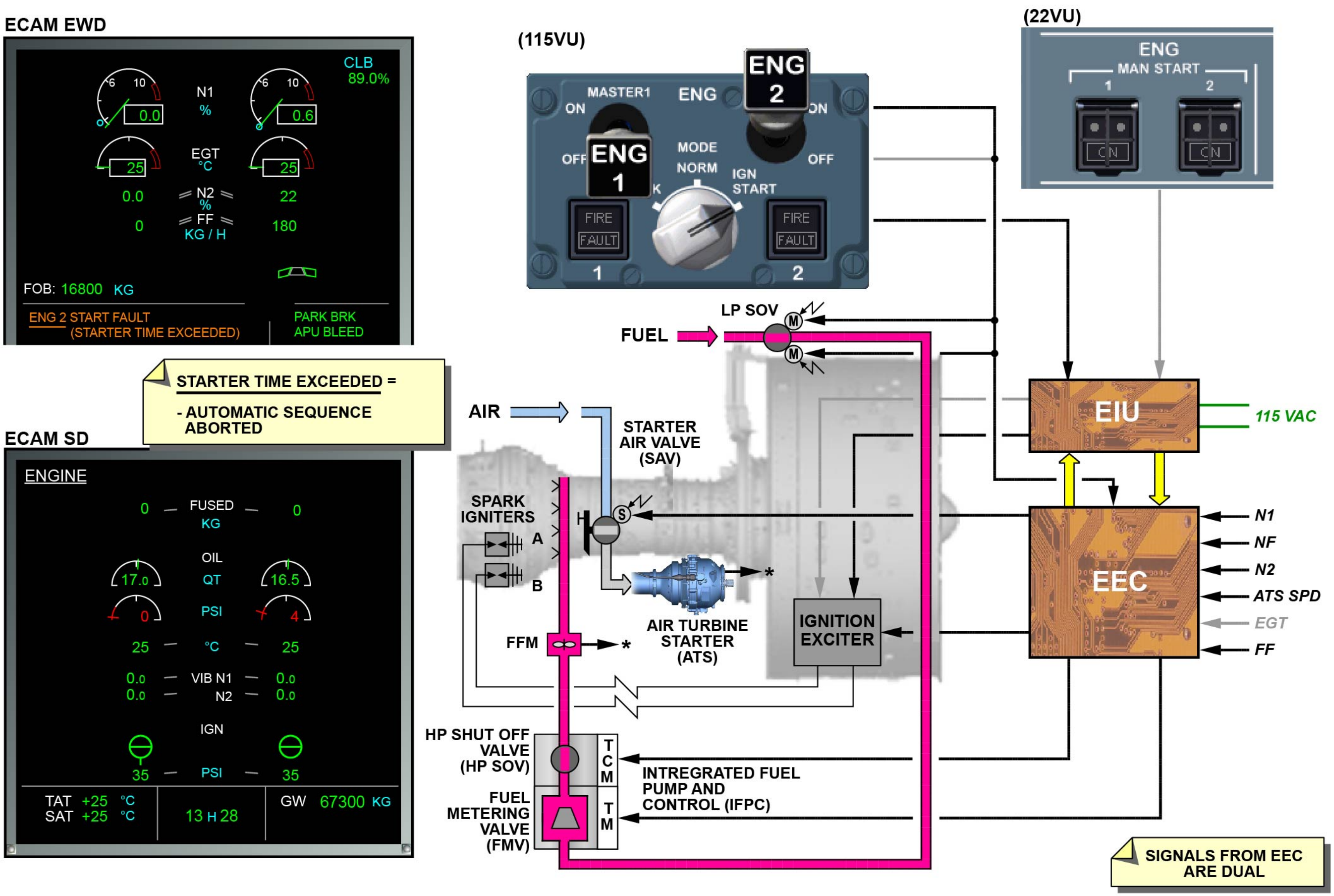
IMPENDING HOT START

UJ515241 - U08T0MEP - UM74D2PW1100G07

START FAILURES (ME) (3)

STARTER TIME EXCEEDED

If during a start or a crank sequence, the EEC identifies an excessive starter duty, it will generate the ECAM alert "ENG x START FAULT (STARTER TIME EXCEEDED)" and abort the automatic sequence.



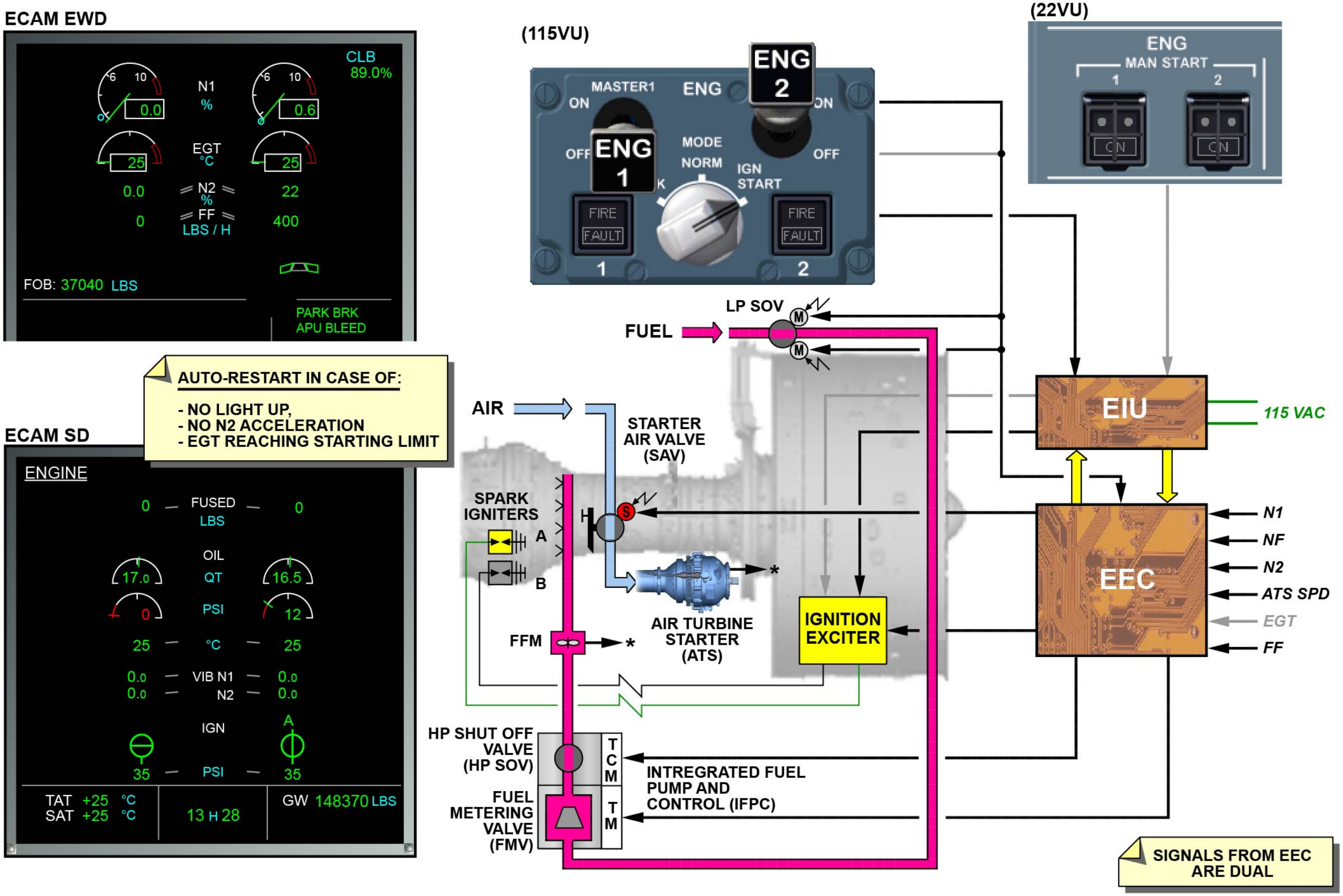
STARTER TIME EXCEEDED

UJ515241 - U08T0MEP - UM74D2PW1100G07

START FAILURES (US) (3)

AUTO-RESTART

The Electronic Engine Computer (EEC) will abort the automatic start, dry motor the engine for 30 seconds and attempt a single auto-restart for the following reasons:
- No light up (Exhaust Gas Temperature (EGT) low and constant),
- No N2 acceleration (hung start),
- EGT reaches starting limit (impending hot start or surge).



AUTO-RESTART

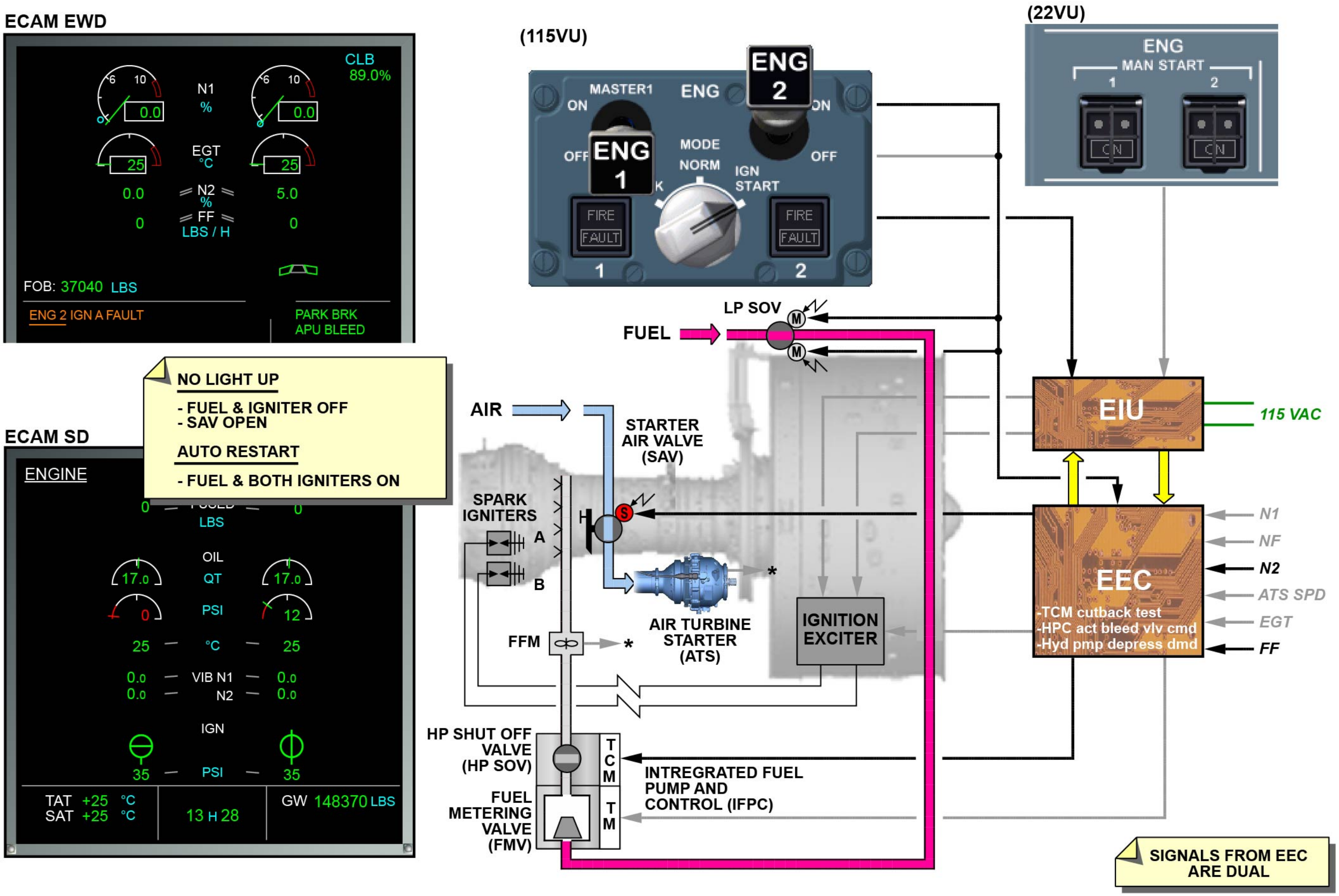
UJ515241 - U08T0MEP - UM74D2PW1100G06

START FAILURES (US) (3)

NO LIGHT UP

If during an automatic start, the EEC identifies a low EGT:
- It shuts down the fuel supply and the selected igniter,
- It generates the ECAM alert "ENG x IGN A(B) FAULT",
- It maintains the Starter Air Valve (SAV) open to clear fuel vapors and cools the turbine for 30 seconds,
- Then it controls simultaneously the fuel flow and both igniters,
- When N2 reaches the starter cutout speed (or the light up is confirmed), it switches the igniters off and controls the SAV closure 1 seconds after (or 1 seconds after the starter duty cycle is exceeded).

The engine continues to accelerate and stabilizes at idle speed.
If this auto-restart attempt fails, the start is aborted and the EEC will generate the ECAM alerts "ENG x START FAULT (IGNITION FAULT)" and "ENG x IGN A+B FAULT".



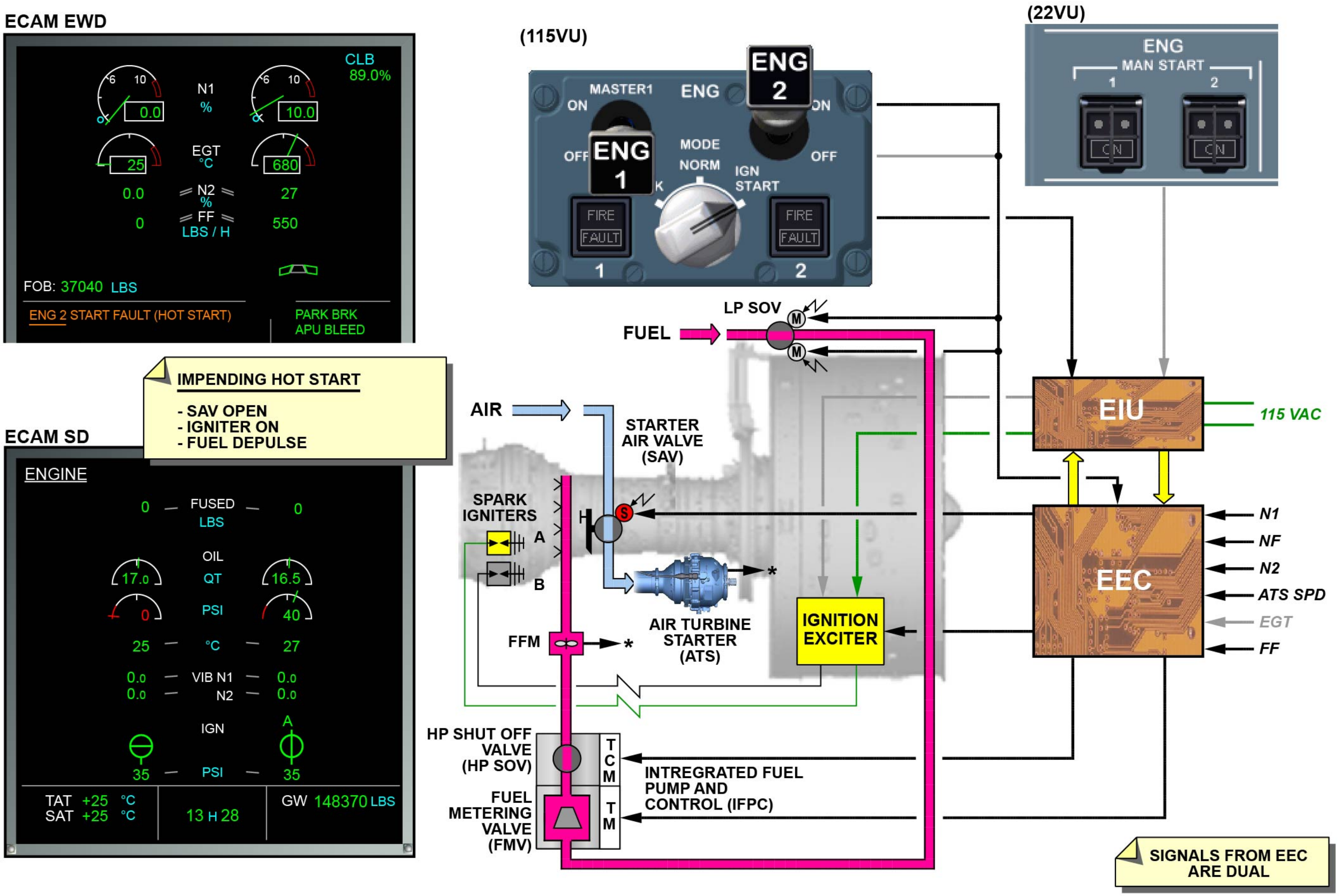
NO LIGHT UP

UJ515241 - U08T0MEP - UM74D2PW1100G06

START FAILURES (US) (3)

IMPENDING HOT START

If during an automatic start, the EEC identifies an impending hot start, it maintains the SAV open, the selected igniter on and controls a fuel depulse procedure: it cycles fuel off for 2 seconds and back on for 12 seconds via the Fuel Metering Valve (FMV) for a maximum of 28 seconds to lower EGT below the limit. The EEC will generate the ECAM alert "ENG x START FAULT (HOT START)".
If the fault disappears, the starting sequence goes on normally up to the engine stabilizes at idle speed.
If the fault is still present, the EEC shuts down the fuel supply and the igniter, performs a dry motor for 30 seconds and attempts a single auto-restart.
If this auto-restart attempt fails, the start is aborted and the EEC will generate the ECAM alert "ENG x START FAULT (EGT OVERLIMIT)"

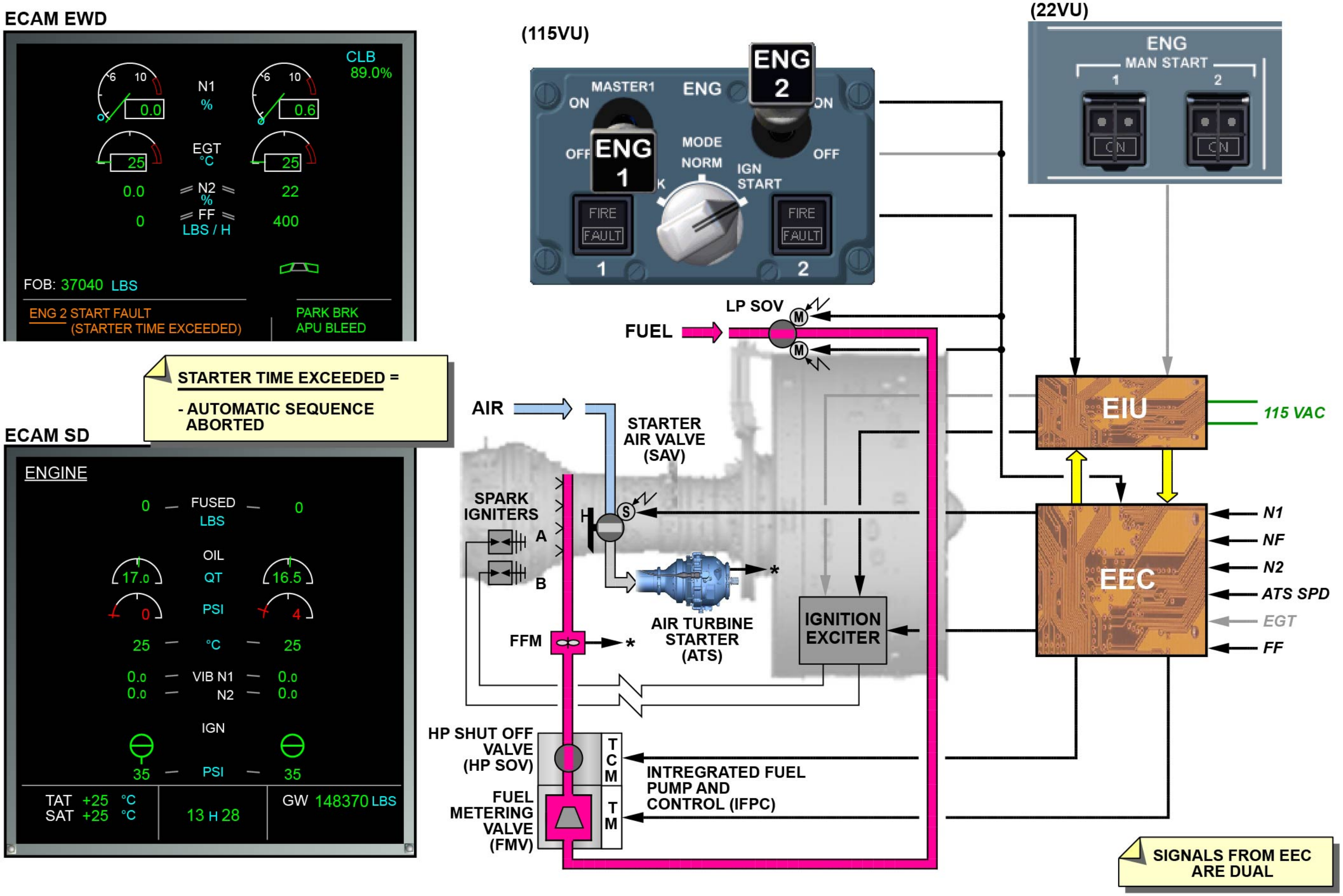


IMPENDING HOT START

START FAILURES (US) (3)

STARTER TIME EXCEEDED

If during a start or a crank sequence, the EEC identifies an excessive starter duty, it will generate the ECAM alert "ENG x START FAULT (STARTER TIME EXCEEDED)" and abort the automatic sequence.

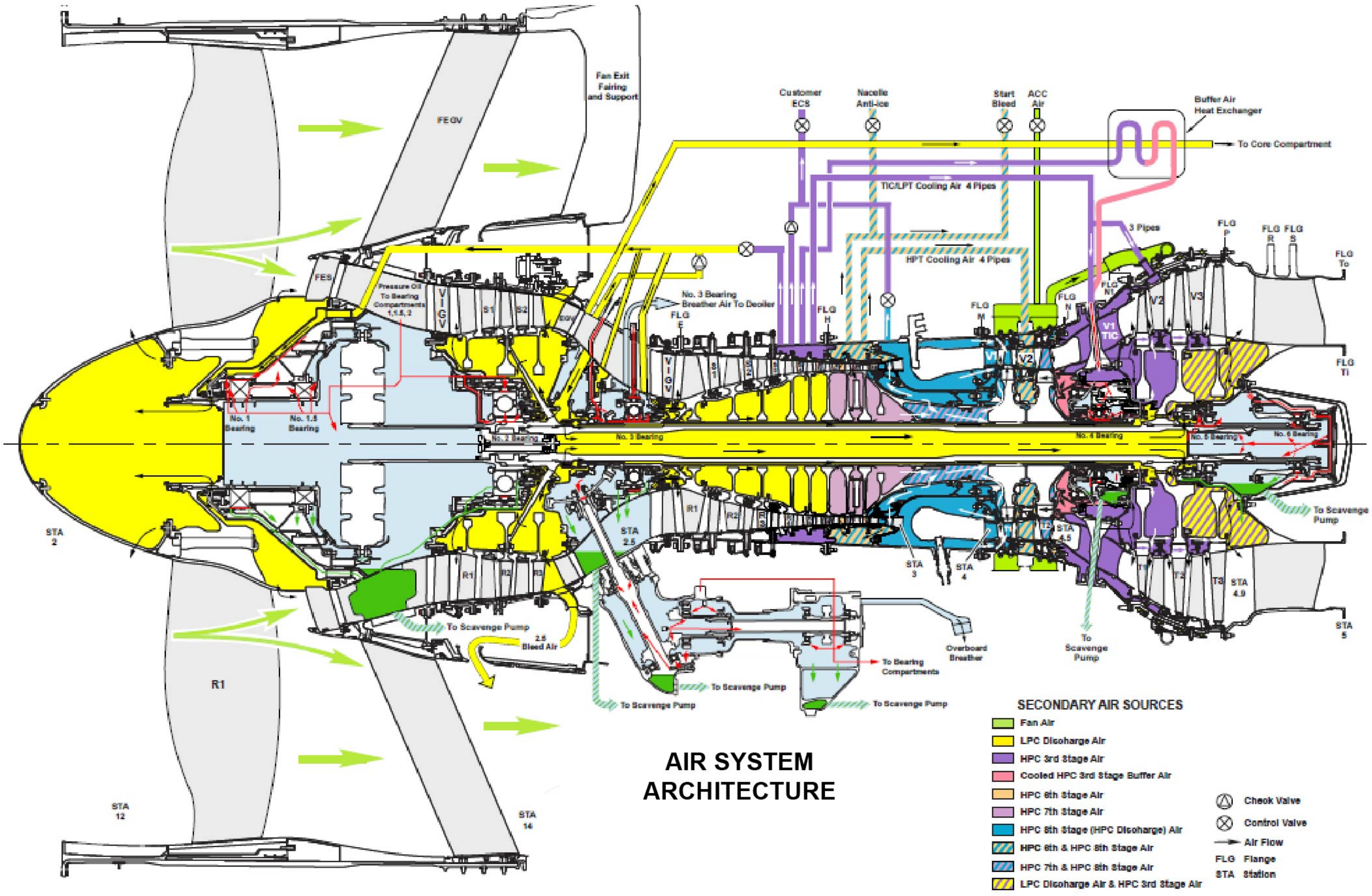


STARTER TIME EXCEEDED

AIR SYSTEM DESCRIPTION/OPERATION (3)

GENERAL

The engine air system makes sure that the compressor airflow and turbine clearances are controlled.
The system also deals with the cooling, pressurizing and ventilation airflows.
External and internal tubing is used to achieve the various functions.
The main air sources are the fan discharge air, Low Pressure Compressor (LPC) discharge air, High Pressure Compressor (HPC) 3rd stage air and HPC 6th stage air.



GENERAL

UJ515241 - U08T0MEP - UM75D1PW1100G04

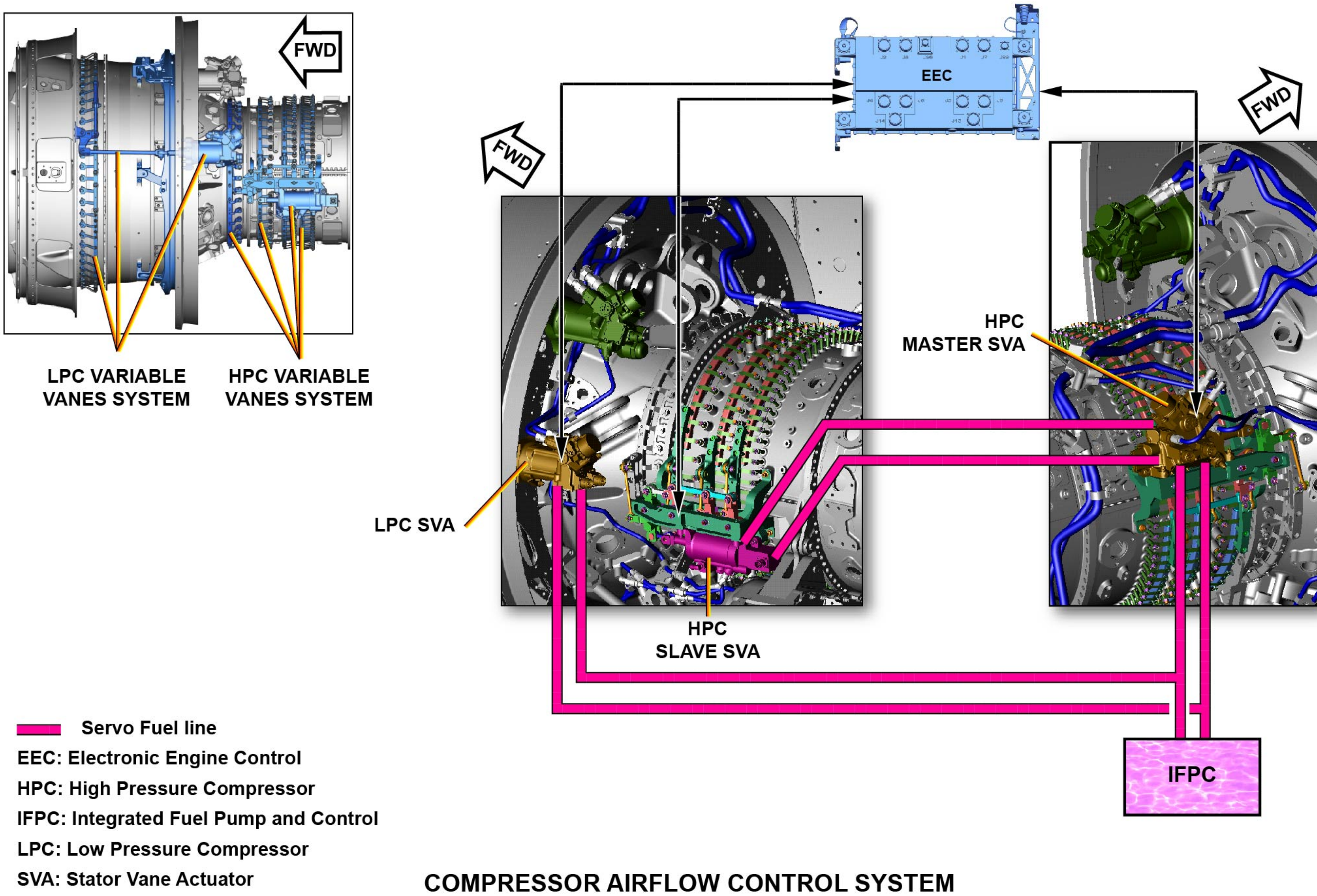
AIR SYSTEM DESCRIPTION/OPERATION (3)

COMPRESSOR AIRFLOW CONTROL

The compressor control system optimizes the compressor performance and its stability during engine start, transient and reverse thrust operations.
The two subsystems that comprise the compressor control system are the:
- Compressor Stator Vane Control System,
- Compressor Bleed Control System.

STATOR VANE CONTROL SYSTEM

The first stage LPC stator vanes and the HPC Inlet Guide Vanes (IGV) and the 1st, 2nd and 3rd HPC stages have variable stator vanes.
The Electronic Engine Control (EEC) controls the vanes positioning to adjust the compressor airflow via three Stator Vane Actuators (SVAs) and mechanical linkages. Each of the LPC SVA and the primary HPC SVA comprises an electrically controlled dual coil torque motor and a fuel operated Electro-Hydraulic Servo Valve (EHSV). The secondary HPC SVA is a slave of the primary. The three SVA Linear Variable Differential Transformers (LVDTs) transmit the piston position to each EEC channel individually.



COMPRESSOR AIRFLOW CONTROL - STATOR VANE CONTROL SYSTEM

UJ515241 - U08T0MEP - UM75D1PW1100G04

AIR SYSTEM DESCRIPTION/OPERATION (3)

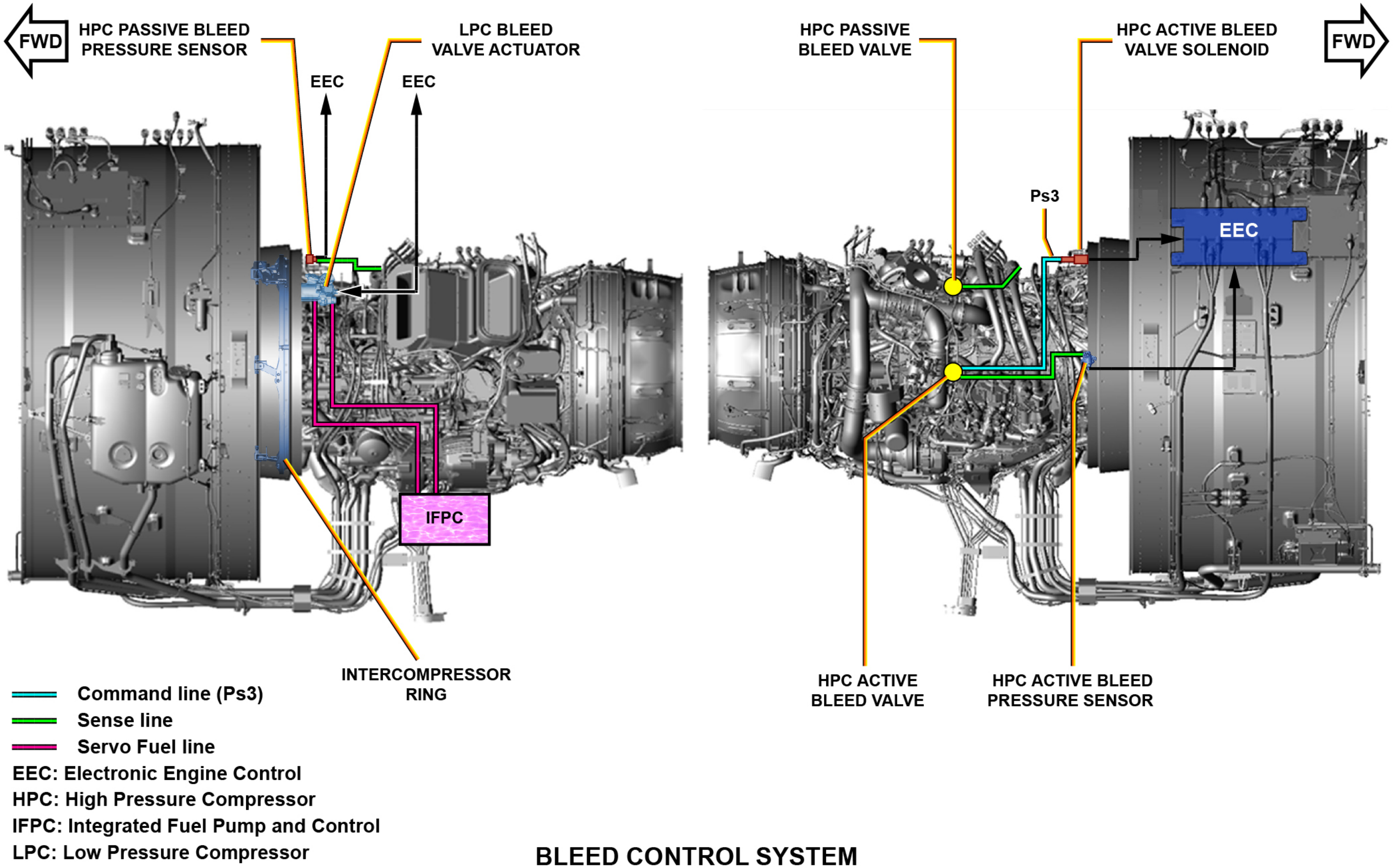
COMPRESSOR AIRFLOW CONTROL (continued)

BLEED CONTROL SYSTEM

The compressor bleed control system comprises one LPC Bleed Valve Actuator (BVA) and two HPC bleed valves.

The LPC bleed system is used to control the LPC discharge 3rd stage airflow into the fan discharge.
The EEC modulates the LPC BVA and mechanical linkages accordingly.
The LPC BVA comprises an electrically controlled dual coil torque motor and a fuel operated EHSV.
The actuator LVDT transmits the piston position to each EEC channel individually.

The HPC bleed system is used to control the HPC 6th stage airflow into the core area.
The system has two ON-OFF HPC bleed valves; one is active, the other passive, and both spring-loaded open and pneumatically closed at certain engine operating conditions.
The active valve is EEC controlled closed through the HPC bleed valve solenoid thanks to Ps3 pressure.
The passive valve closes when the pressure inside the HPC is high enough to force the spring loaded valve closed.
Both are monitored by the EEC thanks to two dedicated pressure sensors.

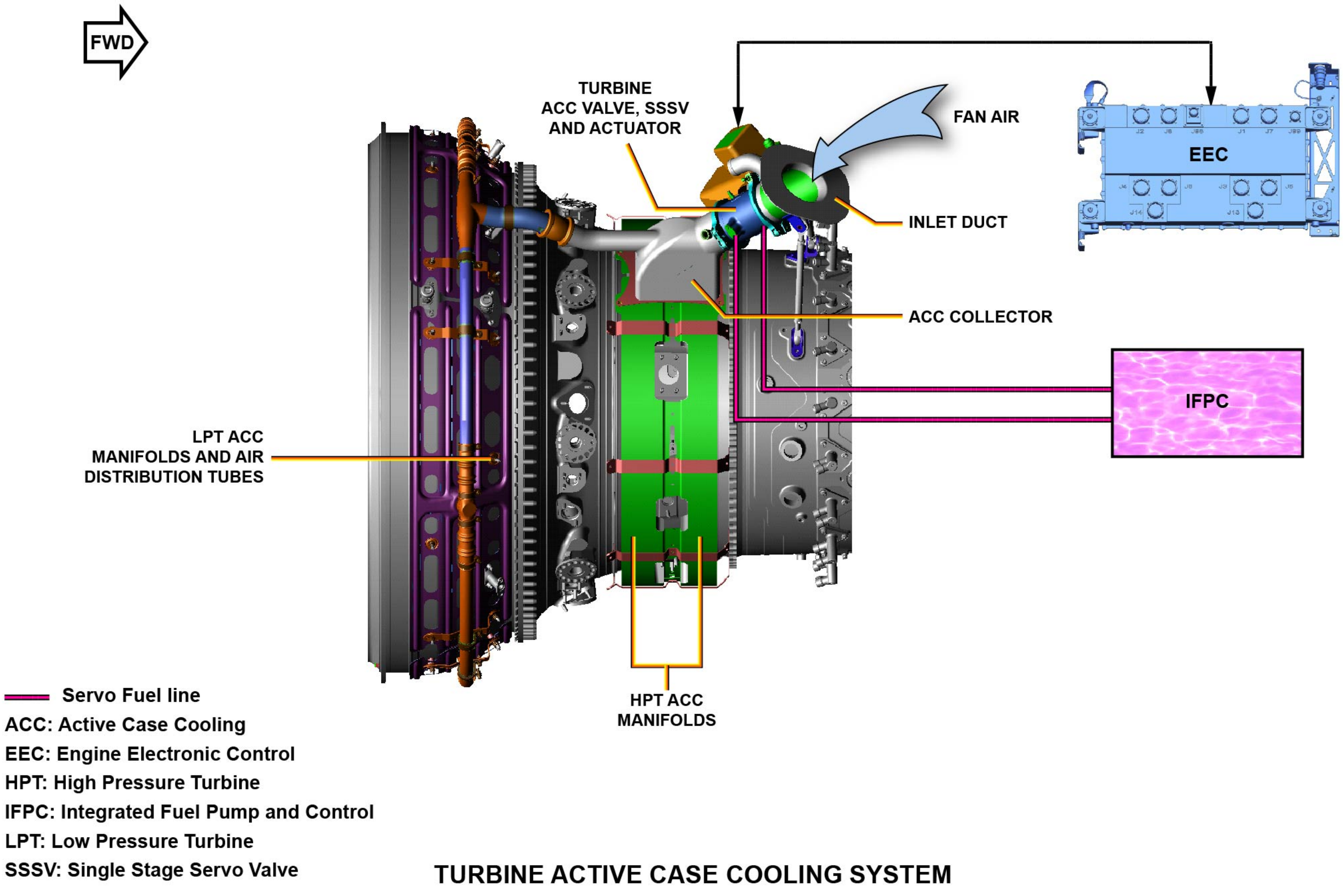


COMPRESSOR AIRFLOW CONTROL - BLEED CONTROL SYSTEM

AIR SYSTEM DESCRIPTION/OPERATION (3)

TURBINE ACTIVE CASE COOLING SYSTEM

The Turbine Active Case Cooling (ACC) system cools and controls the expansion of the turbine case to match the radial expansion of the rotary parts; this improves the fuel efficiency and extends the turbine case life. The EEC modulates the turbine ACC air valve to let some fan air flow be discharged via manifolds and tubes around the LP and HP turbine cases. The turbine ACC air valve comprises an electrically controlled Single Stage Servo Valve (SSSV) and a fuel operated actuator that operates the butterfly. An LVDT transmits the piston position to the EEC channel A.



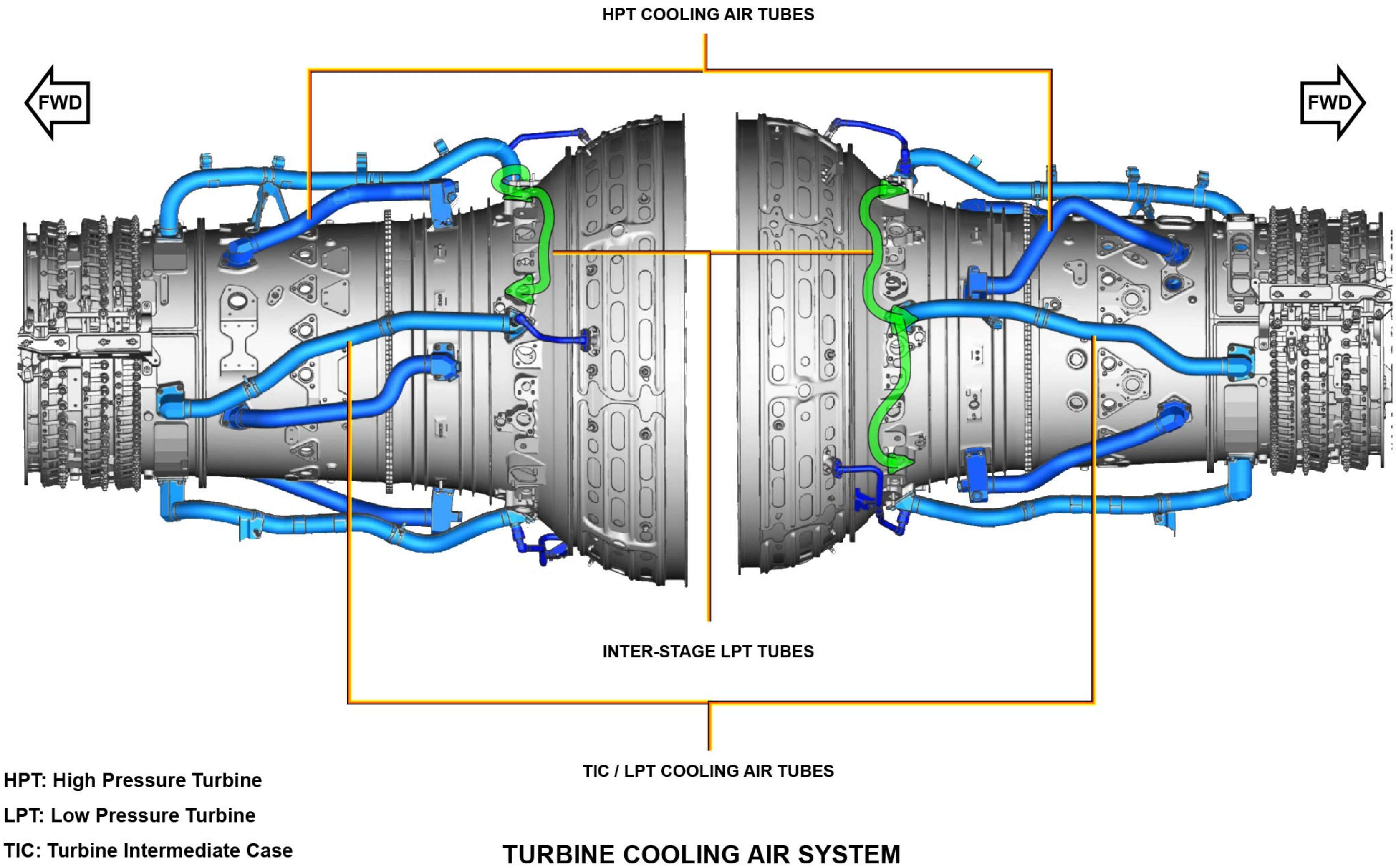
TURBINE ACTIVE CASE COOLING SYSTEM

UJ515241 - U08T0MEP - UM75D1PW1100G04

AIR SYSTEM DESCRIPTION/OPERATION (3)

TURBINE COOLING AIR SYSTEM

The Turbine Cooling Air (TCA) System is a passive system that provides a continuous flow of cooling air inside the turbine cases.
The system consists of 19 external tubes or jumpers that direct calibrated HPC bleed air (3^{rd} and 6^{th} stages) to the followings:
- High Pressure Turbine (HPT) 2^{nd} stage vanes,
- Inter-stage HPT cavity,
- Turbine Intermediate Case (TIC) Stator Vanes, including the inner and outer diameter cavities,
- Low Pressure Turbine (LPT) case outer cavity and LPT rotor inter-stage cavities.



TURBINE COOLING AIR SYSTEM

UJ515241 - U08T0MEP - UM75D1PW1100G04

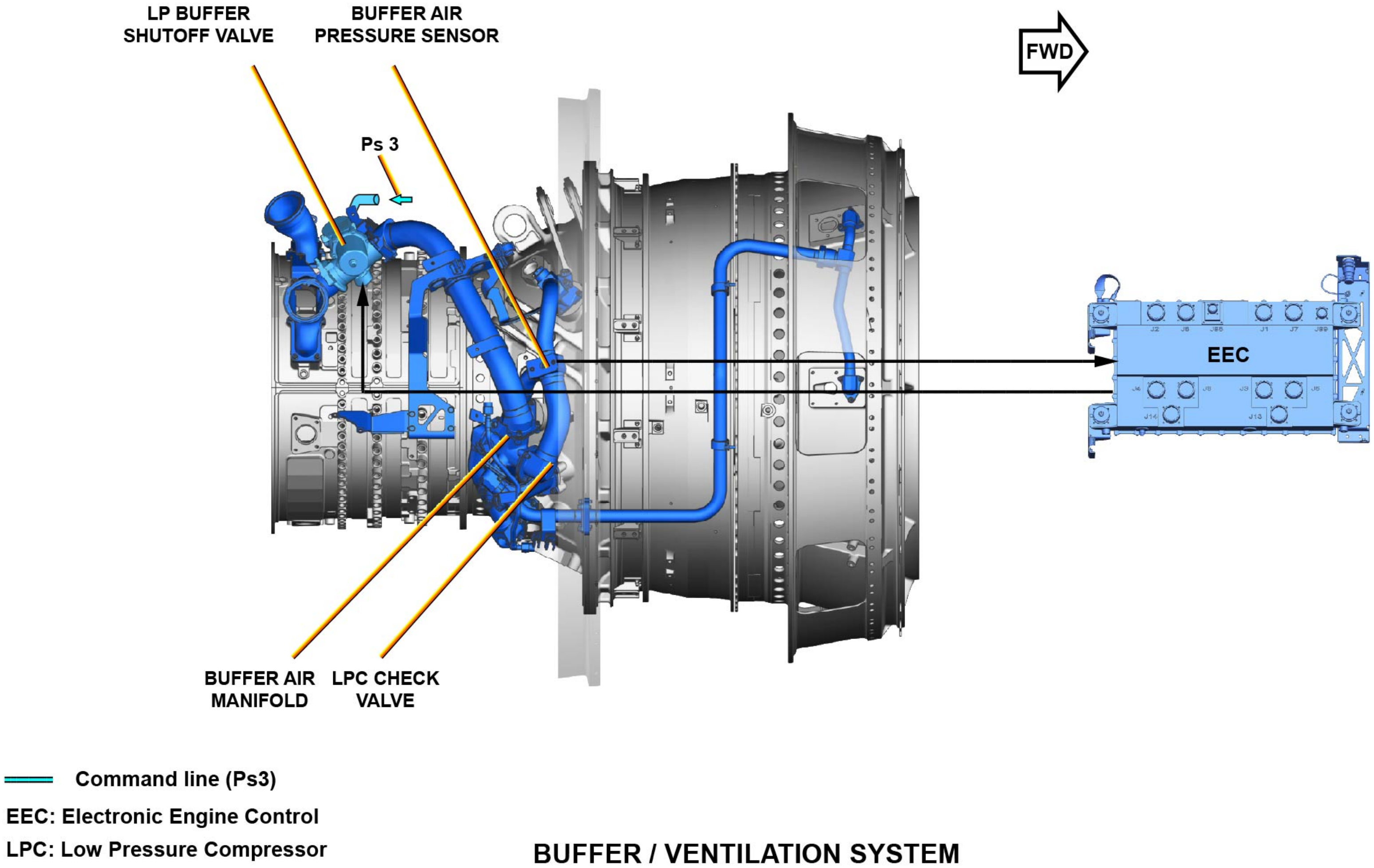
AIR SYSTEM DESCRIPTION/OPERATION (3)

ENGINE BEARING COOLING SYSTEM

The engine bearing cooling system provides cooling buffer air to the engine main bearing compartments and supplies sealing air to prevent oil leakage. It consists of:
- the buffer/ventilation system for bearing numbers 1, 1.5, 2, 3, 5 and 6,
- the engine bearing cooling system for bearing number 4.

BUFFER / VENTILATION SYSTEM

The bearing compartments numbers 1, 1.5, 2, 3, 5 and 6 are cooled and pressurized by the HPC 3^{rd} stage through the LP buffer shutoff valve at low power or by the 2.5 bleed air valve at high power through the LPC check valve.
The LPC check valve is a passive device that is open until the HPC 3^{rd} stage pressure delivered by the LP buffer shutoff valve is higher than the 2.5 pressure, to prevent a reverse flow.
The LP buffer shutoff valve is open through the integrated EEC controlled HPC buffer shutoff valve solenoid thanks to Ps3 pressure.
The cooling buffer air is distributed to the bearing compartments via external and internal tubing, including LP shaft.
For monitoring, the Buffer Air Pressure Sensor (BAPS) provides a buffer air pressure signal to both EEC channels.



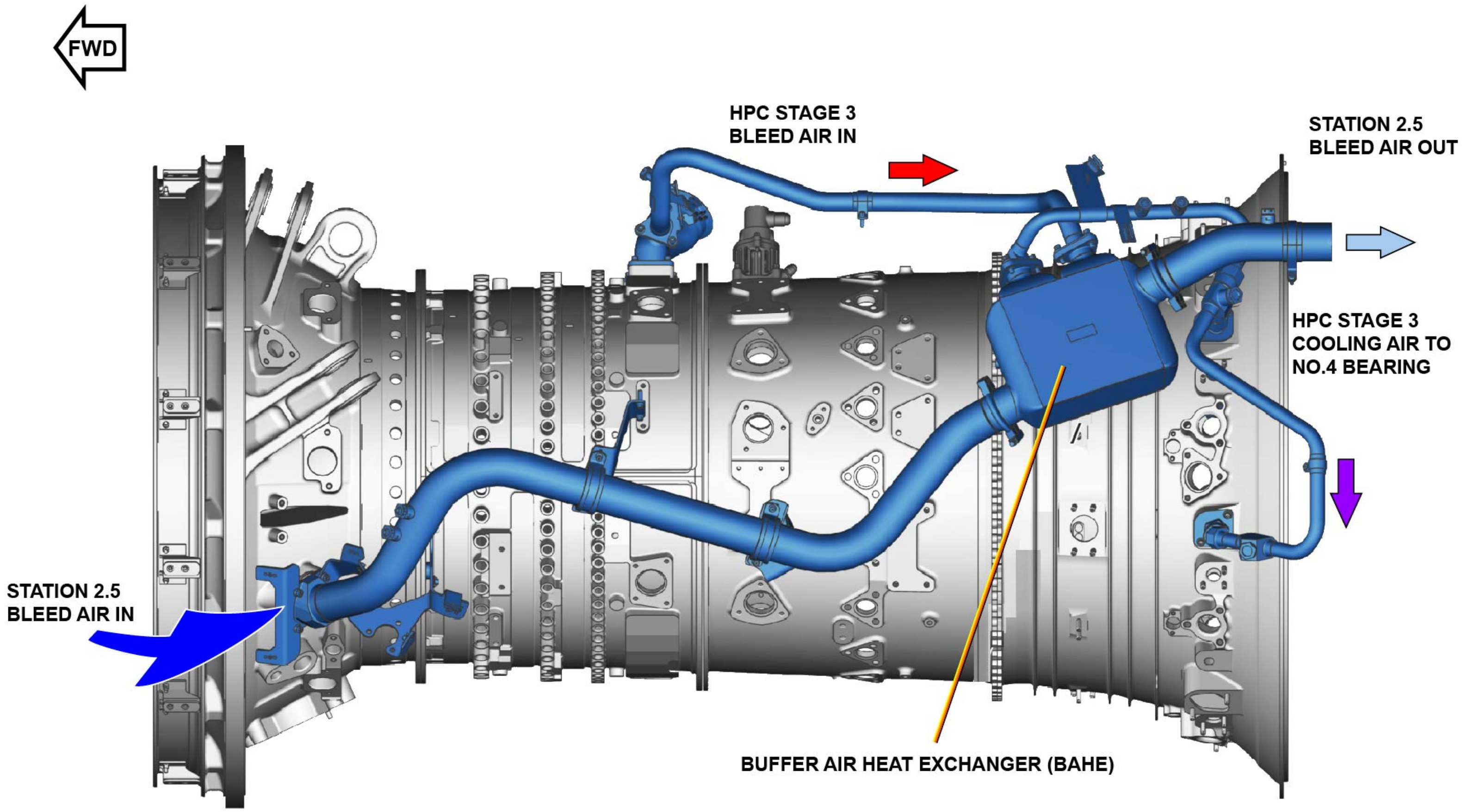
ENGINE BEARING COOLING SYSTEM - BUFFER / VENTILATION SYSTEM

AIR SYSTEM DESCRIPTION/OPERATION (3)

ENGINE BEARING COOLING SYSTEM (continued)

NUMBER 4 BEARING COOLING SYSTEM

The Buffer Air Heat Exchanger (BAHE) uses station 2.5 bleed air to cool HPC 3^{rd} stage air before it is delivered to the number 4 bearing housing. The station 2.5 air exits the BAHE and is routed into the fan discharge.



HPC: High Pressure Compressor

ENGINE BEARING COOLING SYSTEM

ENGINE BEARING COOLING SYSTEM - NUMBER 4 BEARING COOLING SYSTEM

UJ515241 - U08T0MEP - UM75D1PW1100G04

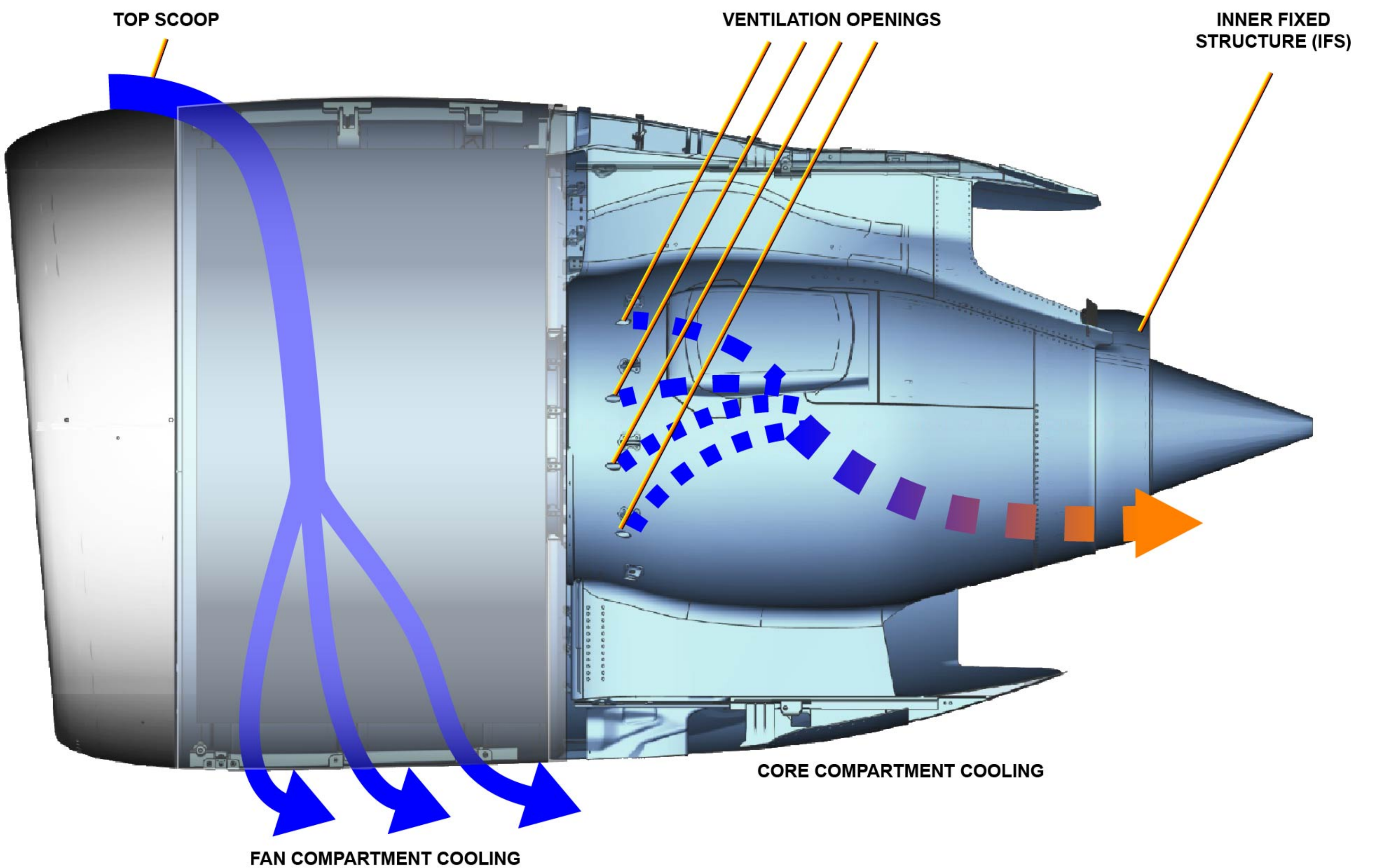
AIR SYSTEM DESCRIPTION/OPERATION (3)

COMPARTMENT COOLING

The compartment cooling system ensures the ventilation of the fan compartment, the core compartment and dedicated components inside the core compartment.

The cooling of the fan compartment is achieved through a passive ventilation system. Outside airflow circulates from the top scoop around the fan case and exhausts through bottom holes and gabs of the fan cowls.

The cooling of the core compartment is achieved through a passive ventilation system. Fan bypass airstream is directed to the nacelle core, ignition leads, igniter plugs and Environmental Control System (ECS) bleed valves through openings on the inner contour of the thrust reverser cowl doors and exhausts through bottom holes and gabs of the Inner Fixed Structure (IFS) trailing edge. Additional tubes are dedicated for the cooling of the ACC Valve, Starter Air Valve (SAV) and the Flow Divider Valve (FDV).



COMPARTMENT COOLING SYSTEM

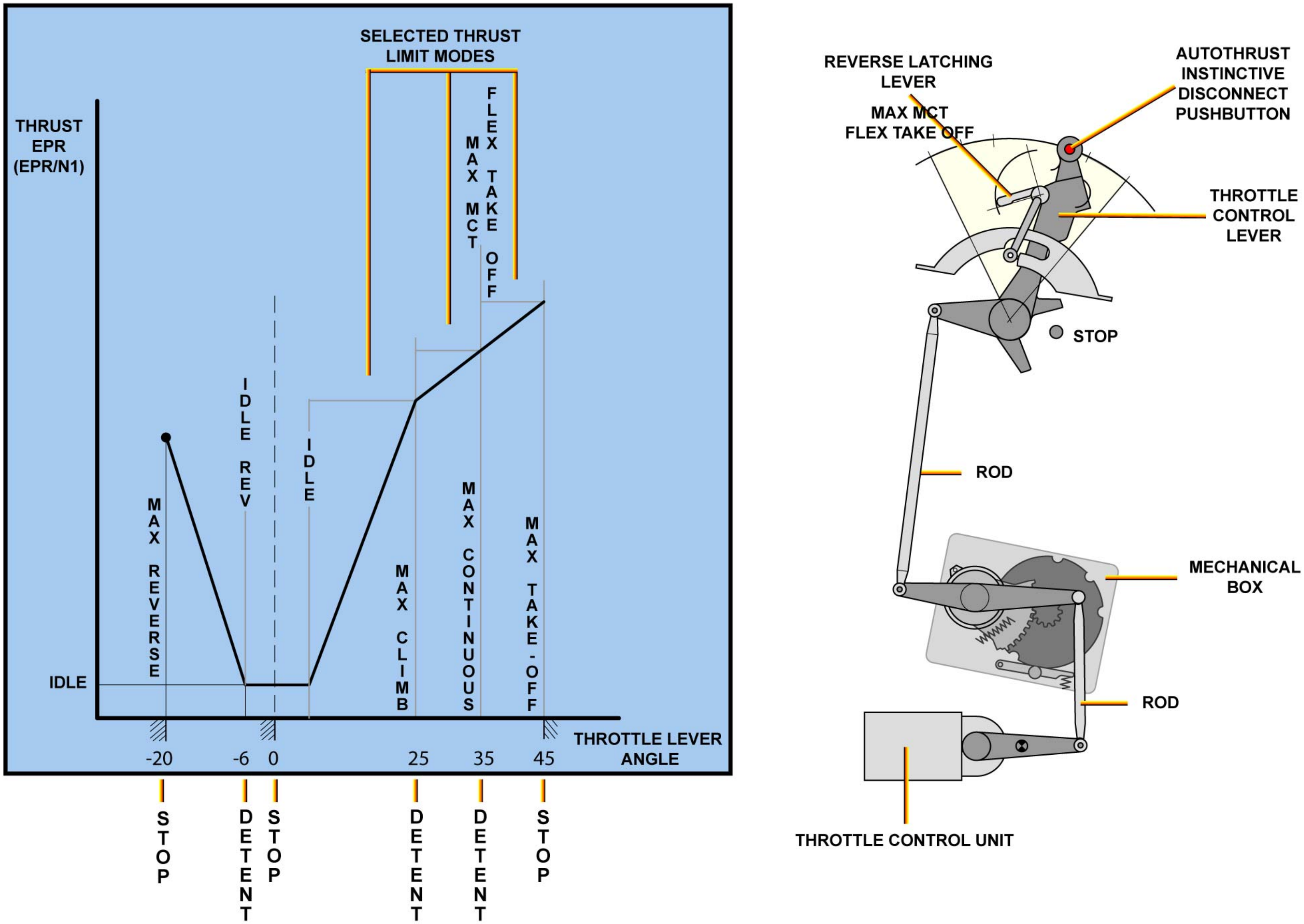
COMPARTMENT COOLING

UJ515241 - U08T0MEP - UM75D1PW1100G04

THROTTLE CONTROL SYSTEM D/O (3)

THROTTLE CONTROL LEVER

The Throttle control handle comprises:
o a throttle control lever which incorporates stop devices, autothrust instinctive disconnect pushbutton switch
o a graduated fixed sector
o a reverse latching lever.
The throttle control lever is linked to a mechanical rod. This rod drives the input lever of the throttle control artificial feel unit.
The throttle control lever moves over a range from -20 deg.TLA (Reverser Full Throttle stop) to +45 deg.TLA:
o -20 degrees TLA corresponds to Reverser Full Throttle stop
o +45 degrees TLA corresponds to Forward Full Throttle stop
An intermediate mechanical stop is set to 0 deg. TLA. This stop is overridden when the reverse latching lever is pulled up for selection of the reverse power. This stop is reset as soon as the throttle control lever is selected back to forward thrust area.
In the forward thrust area, there are two detent points, the MAX CLIMB detent point set to 25 deg.TLA and the MAX CONTINUOUS/FLEX TAKE-OFF detent point set to 35 deg.TLA.
In the reverse thrust throttle range, there is one detent point at - 6 deg.TLA. This position agrees with the selection of the thrust reverser command and the Reverse Idle setting.
In the middle throttle range (0 deg. To 35 deg.TLA), the autothrust function can be active if engaged. This range agrees with the selection of MAX CLIMB or MAX CONTINUOUS thrust limit mode (in single operation). If the autothrust is not engaged, the engine control is manual.
In the forward range (35 deg. To 45 deg.TLA), the autothrust function cannot be activated (except in alpha floor condition).This range agrees with the selection of FLEX TAKE-OFF/MAX TAKE-OFF Mode.



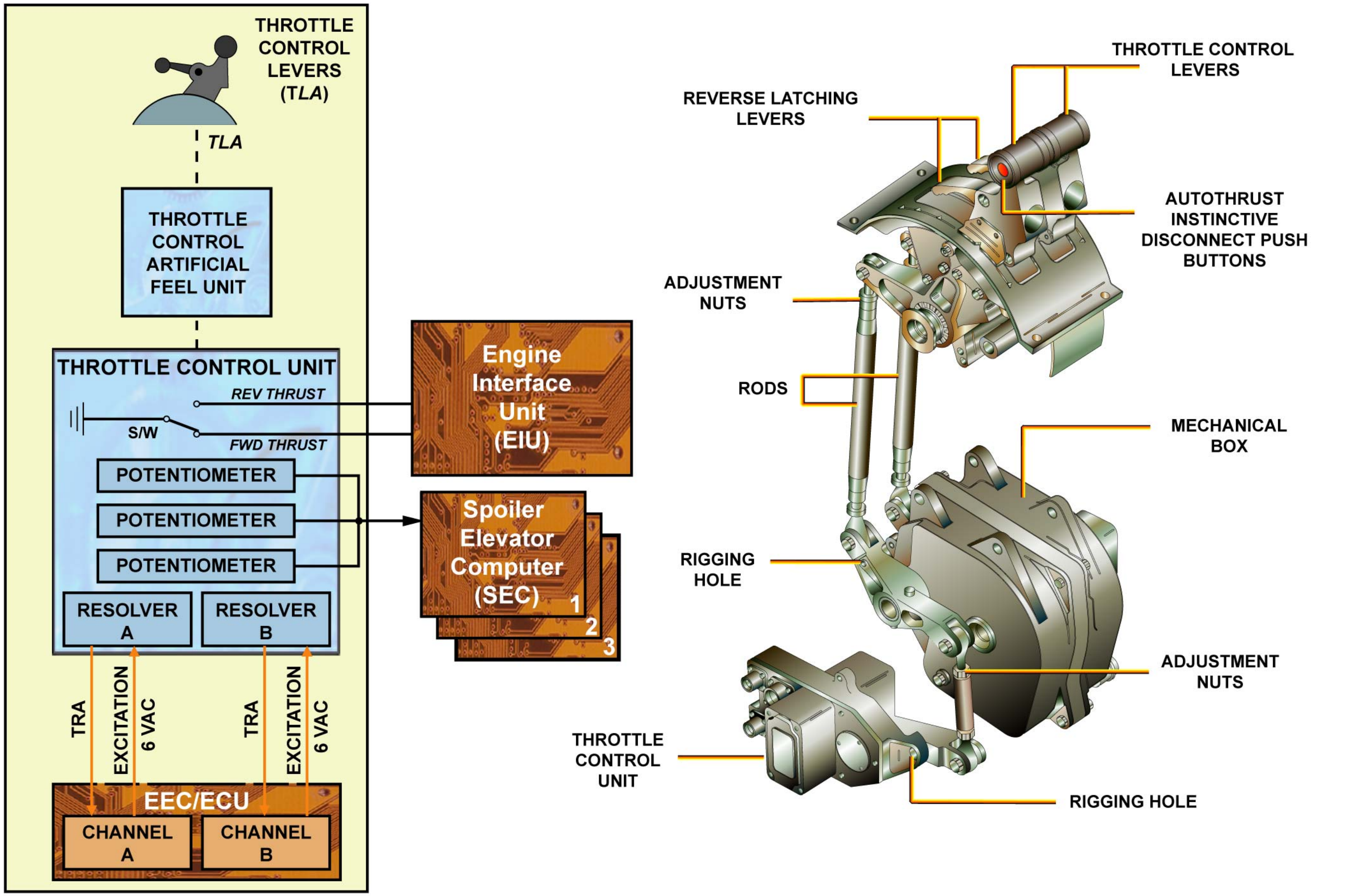
THROTTLE CONTROL LEVER

UJ515241 - U08T0MEP - UM76D5000000001

THROTTLE CONTROL SYSTEM D/O (3)

THROTTLE CONTROL UNIT

A mechanical rod transmits the throttle control lever movement. It connects the throttle artificial feel unit to the input lever of the throttle control unit. The throttle control unit comprises:
-An input lever
-Mechanical stops, which limit the angular range
-2 resolvers (one resolver per FADEC (ECU/EEC)
-6 potentiometers installed three by three
-A device, which drives the resolver and the potentiometer
-A pin device for rigging the resolver and potentiometers
-1 switch whose signal is dedicated to the EIU
-2 output electrical connectors
The input lever drives two gear sectors assembled face to face. Each sector drives itself a set of one resolver and three potentiometers. The relationship between the throttle lever angle and throttle resolver angle (TRA) IS LINEAR AND 1 DEG.TLA = 1.9 TRA. The accuracy of the throttle control unit (error between the input lever position and the resolver angle) is 0.5 deg.TRA. The maximum discrepancy between the signals generated by two resolvers is 0.25 deg.TRA.
The TLA resolver operates in two quadrants. The first quadrant is used for positive angles and the second quadrant for negative angles. Each resolver is dedicated to one FADEC channel (ECU / EEC) and receives its electrical excitation current (6 VAC) from the related FADEC channel (ECU / EEC)
The ECU considers a throttle resolver angle value:
o less than -47.5 deg.TRA
or
o greater than 98.8 deg.TRA as resolver position signal failure.
The ECU includes a resolver fault accommodation logic. This logic allows engine operation after a failure or a complete loss of the throttle resolver position signal.



THROTTLE CONTROL UNIT

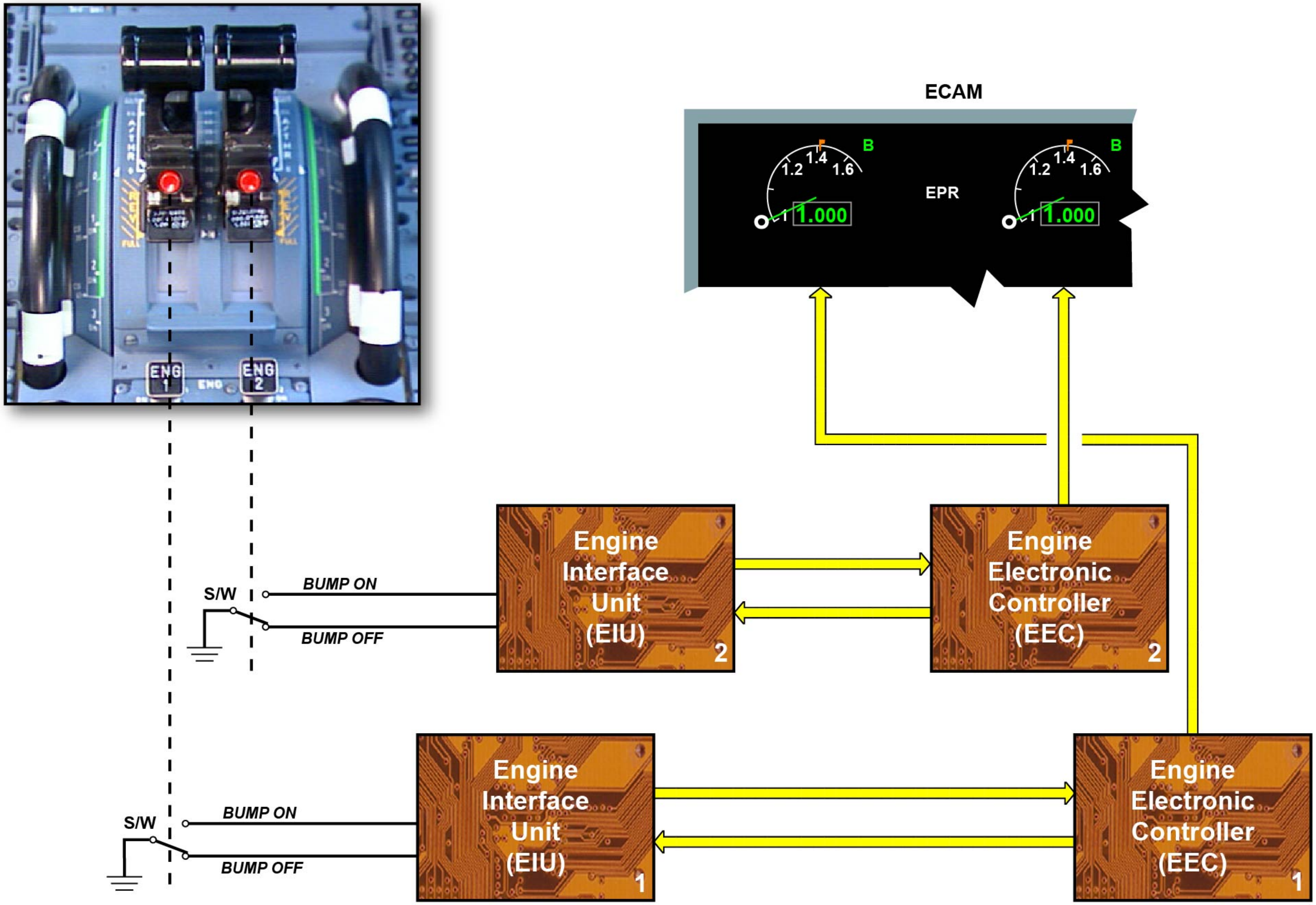
UJ515241 - U08T0MEP - UM76D5000000001

THROTTLE CONTROL SYSTEM D/O (3)

BUMP FUNCTION (PW1100G and IAE ENGINES ONLY)

If an airline requests the bump function, this function is selected in the aircraft by guarded pushbutton switch with TLA at TOGA position (one on each throttle control lever). With this switch, a signal can be sent to the two FADEC units at the same time through the Engine Interface Unit (EIU).
Thrust bump can be used to obtain additional thrust capability during takeoff It can be used either with two engines or in single engine operation.
With the throttle levers at TOGA and the Bump P/B pushed, 'B' appears on the right side of the EPR/N1 dial on the EWD.

UJ515241 - U08T0MEP - UM76D5000000001



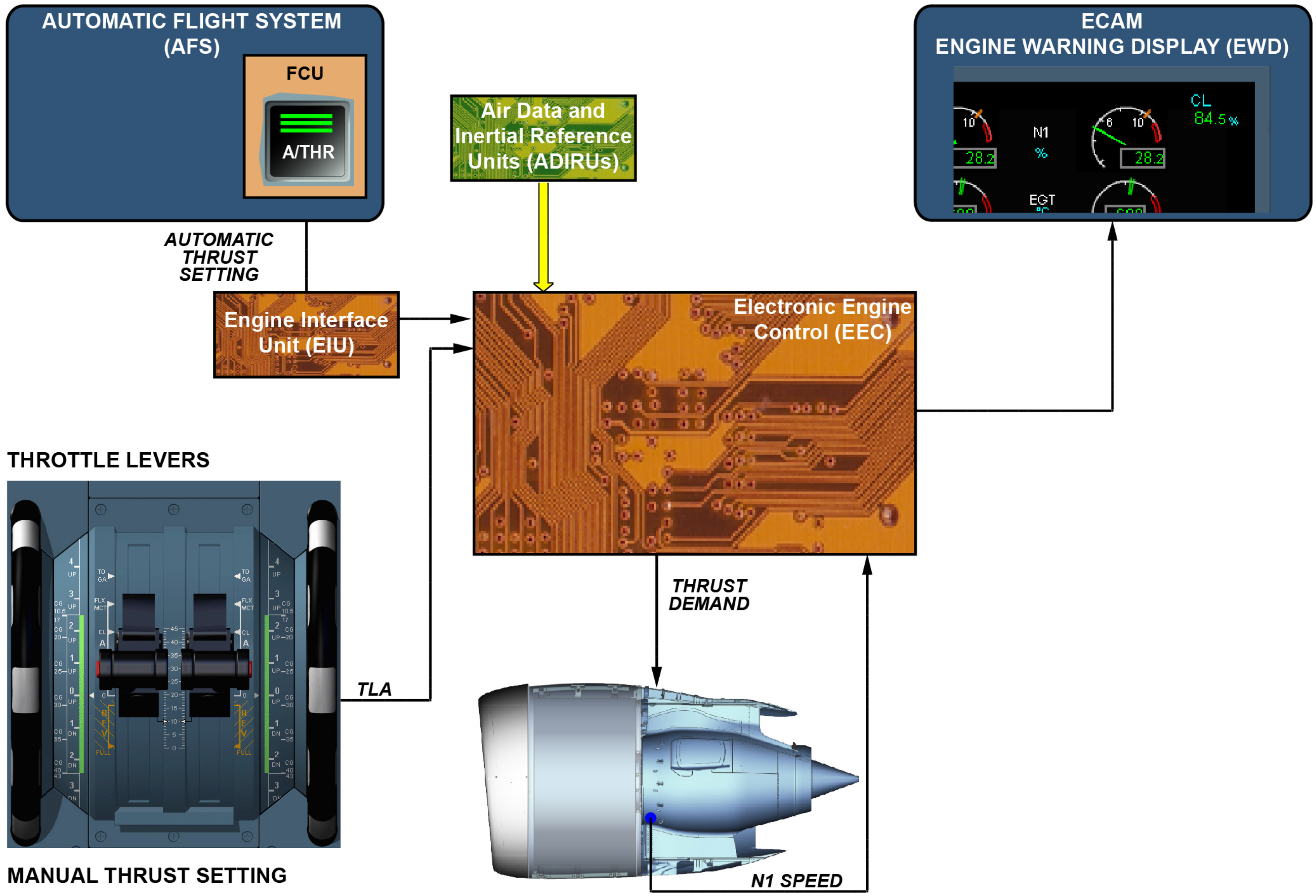
BUMP FUNCTION (PW1100G AND IAE ENGINES ONLY)

ENGINE THRUST MANAGEMENT (3)

GENERAL

The engine thrust is controlled under the management of the Electronic Engine Controller (EEC).
The engine thrust can be set:
- manually from the throttle control lever or,
- automatically from the Auto Flight System (AFS).

The engine thrust parameters are displayed on the ECAM.
The main thrust monitoring parameter is the N1 speed (LP shaft).
The main thrust demand parameter is the engine Fuel Flow (FF).



GENERAL

UJ515241 - U08T0MEP - UM76D1PW1100G04

ENGINE THRUST MANAGEMENT (3)

THRUST LIMIT MODE

The throttle levers are used as thrust limit mode selectors.
Depending on the throttle lever position, a thrust limit mode is selected and appears on the upper ECAM display.
If the throttle levers are set between two detent points, the upper detent will determine the thrust limit mode.
An additional Soft Go-Around (SGA) mode is available.
It is automatically selected if during approach, the TOGA detent is set and the thrust levers are then moved back to the FLX/MCT detent.

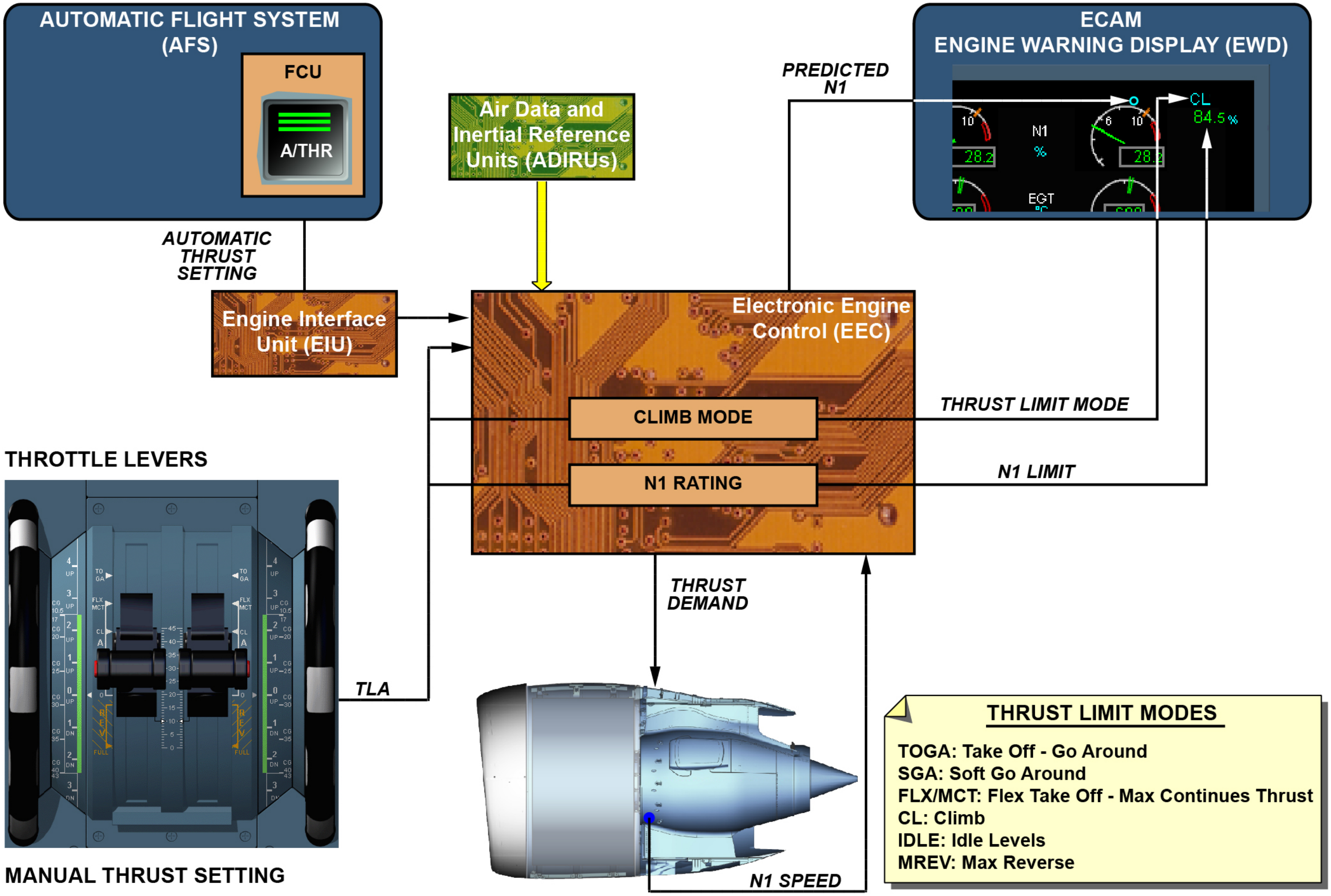
NOTE: Note:
- On the ground with the engines running, the displayed N1 rate limit corresponds to the TO/GA thrust limit whatever the thrust lever position is.
- On the ground with the engines running and if FLEX mode is selected, FLEX N1 is displayed whenever the thrust lever position is between IDLE and FLX/MCT.

N1 LIMIT

For each thrust limit mode selection, an N1 rating limit is computed by the EEC according to Thrust Lever Angle (TLA) and the air data parameters from the Air Data Inertial and Reference Units (ADIRUs). This indication is displayed in green on the upper ECAM display near the thrust limit mode indication.

PREDICTED N1

The predicted N1 is indicated by a blue circle on the N1 indicator and corresponds to the value determined by the TLA.



THRUST LIMIT MODE - N1 LIMIT & PREDICTED N1

ENGINE THRUST MANAGEMENT (3)

ACTUAL N1

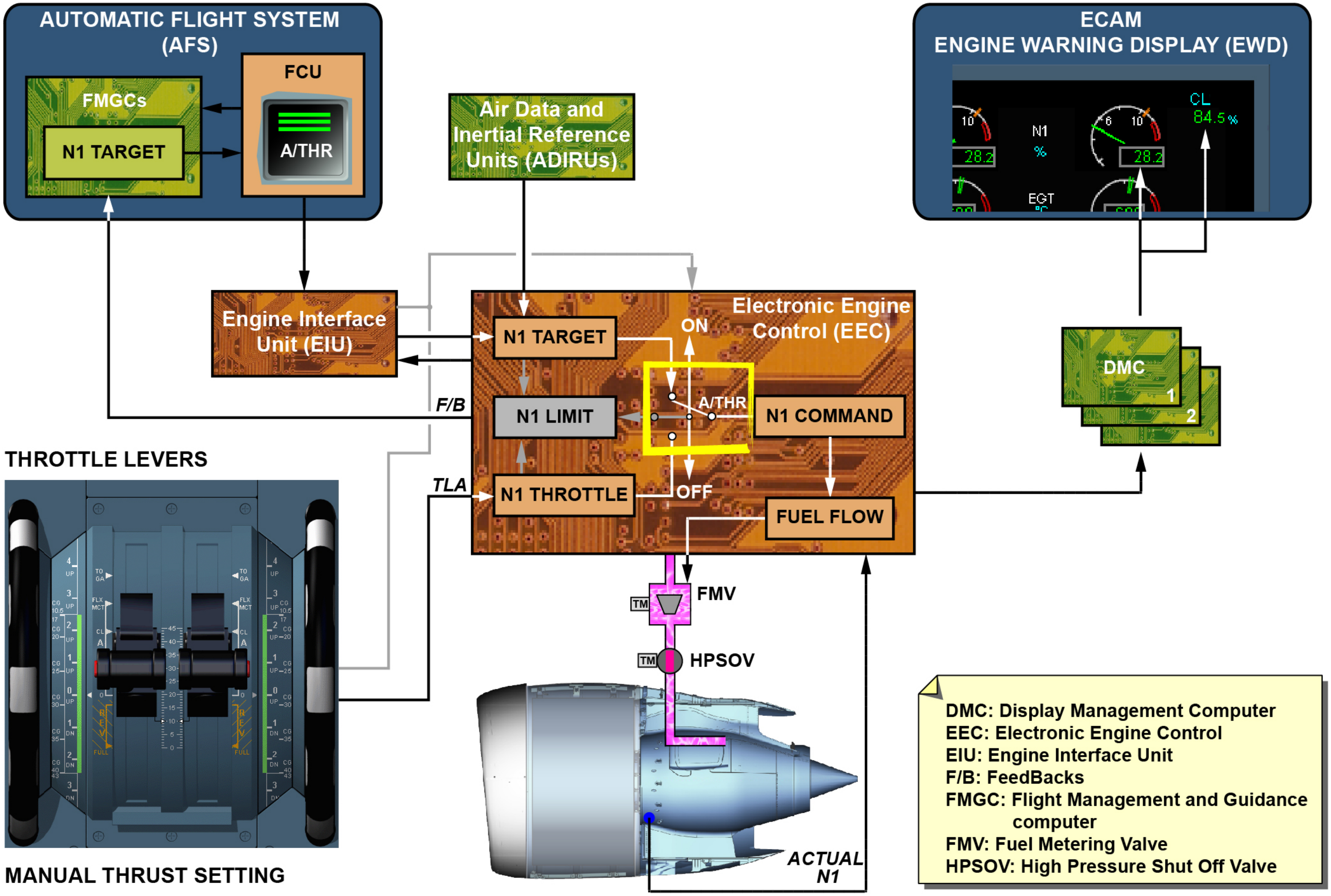
The actual N1 is the actual value given by the N1 speed sensor and is used as a reference for the engine thrust control loop.
This actual N1 is displayed in green on the N1 indicator.

N1 COMMAND

The N1 command, used to regulate the fuel flow, is:

N1 TARGET

In A/THR mode, the FMGCs compute an N1 target according to the AFS command, the air data and the engine parameters and send this demand to the EECs.



ACTUAL N1 - N1 COMMAND & N1 TARGET

ENGINE THRUST MANAGEMENT (3)

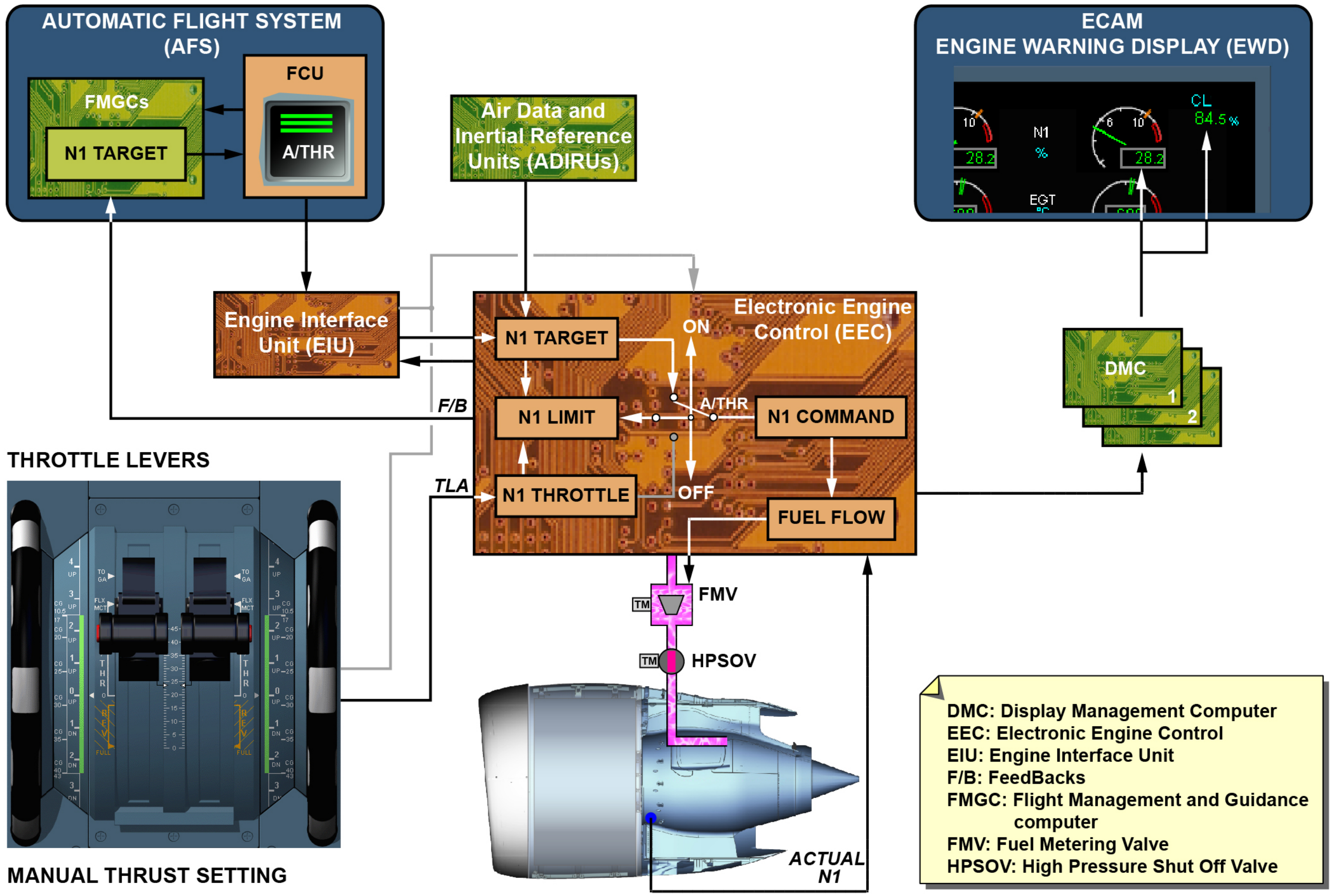
AUTOTHRUST CONTROL MODE

The A/THR function is engaged manually when the A/THR P/B is selected or automatically at take-off power application.

AUTOTHRUST ACTIVE

When engaged, the A/THR function becomes active when the throttle levers are set to CLimb detent after take-off.
The N1 command is the FMGC N1 target.
The A/THR function is normally active when the throttle levers are set between IDLE and CLimb (including CLimb).
The A/THR active range is extended to MCT in the case of single engine operation.
When the throttle levers are set between two detent points, the N1 command is limited by the throttle lever position.

NOTE: Note: In case of Alpha Floor detection, the A/THR function becomes active automatically and the N1 target is to TOGA.



AUTOTHRUST CONTROL MODE - AUTOTHRUST ACTIVE

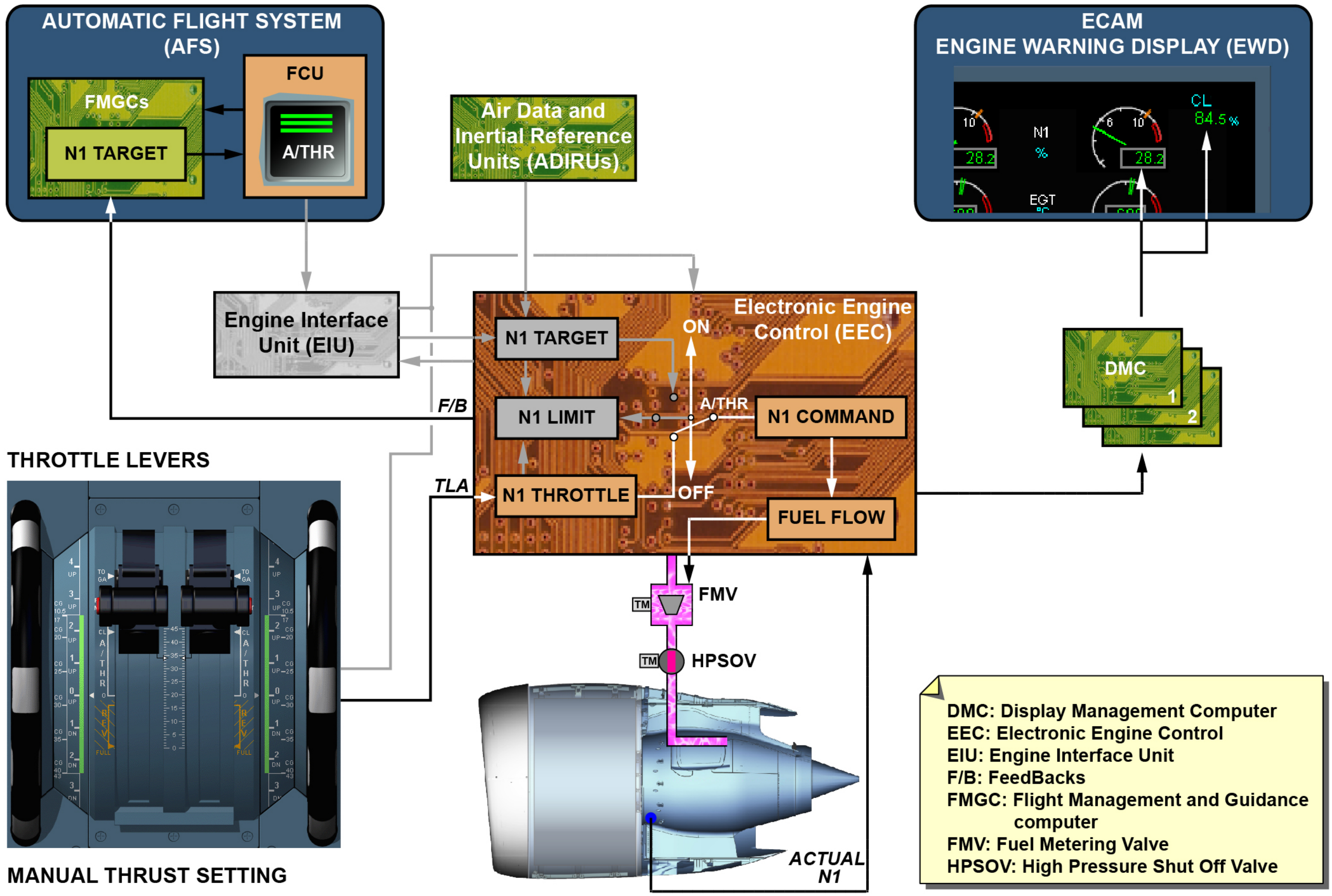
ENGINE THRUST MANAGEMENT (3)

AUTOTHRUST CONTROL MODE (continued)

AUTOTHRUST NOT ACTIVE

When engaged, the A/THR function becomes inactive when the throttle levers are set above CLimb with both engines running.
In this case, the N1 command corresponds to the N1 throttle (TLA).

NOTE: Note:
The A/THR function is inactive above MCT in case of single engine operation.
The A/THR function is disengaged when the throttle levers are set at IDLE stop.



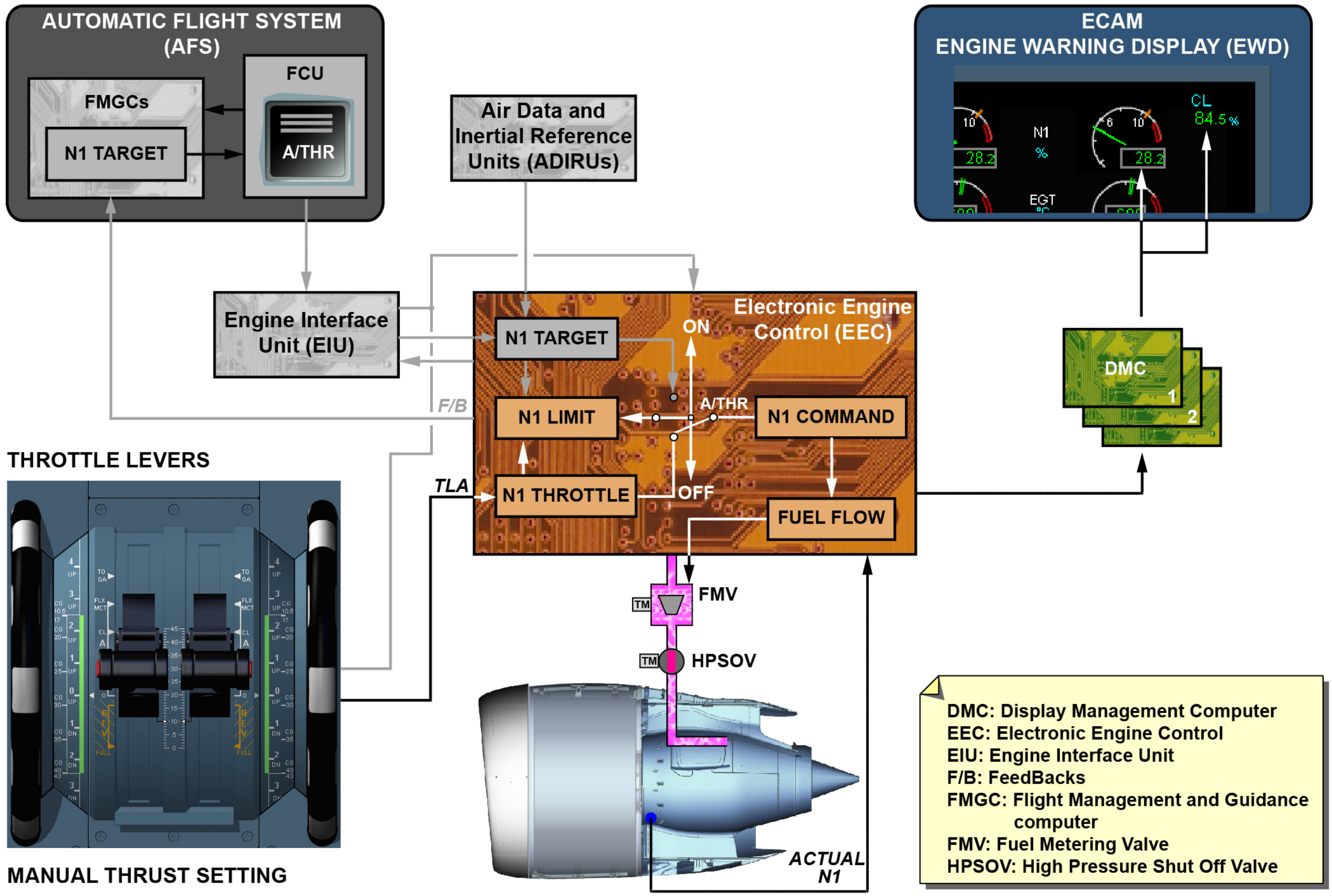
AUTOTHRUST CONTROL MODE - AUTOTHRUST NOT ACTIVE

ENGINE THRUST MANAGEMENT (3)

AUTOTHRUST CONTROL MODE (continued)

MANUAL CONTROL MODE

The engines are in manual control mode when the A/THR function is not engaged, or engaged and not active (throttle levers not in the A/THR operating range and no Alpha Floor detected).



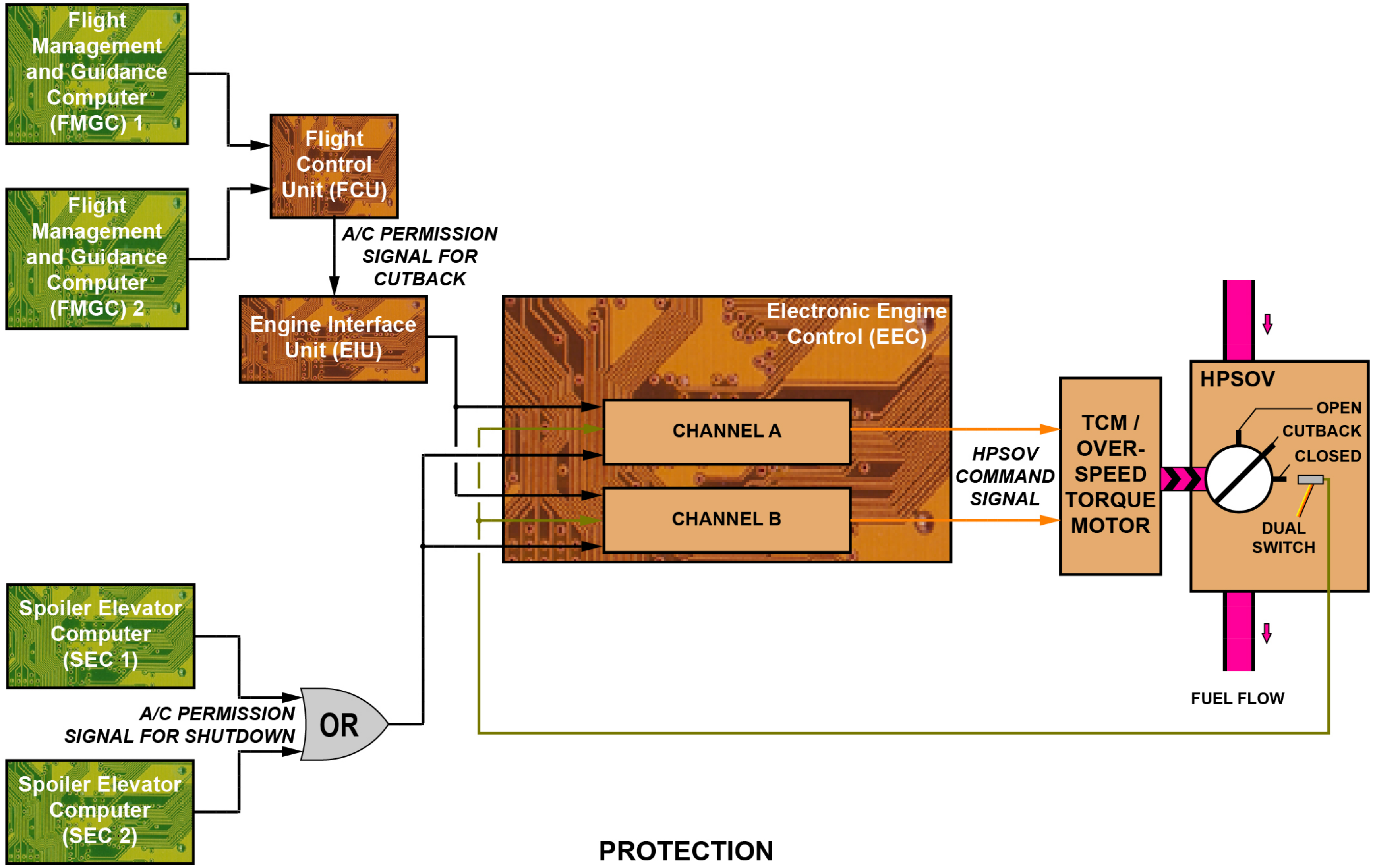
AUTOTHRUST CONTROL MODE - MANUAL CONTROL MODE

ENGINE THRUST MANAGEMENT (3)

THRUST CONTROL MALFUNCTION

The Thrust Control Malfunction (TCM) is a FADEC protection function against un-commanded and uncontrollable excessive power excursion in which the normal thrust control becomes inoperative.

NOTE: Note: The FADEC logic uses TCM permission data from FMGCs to FCU to automatically reduce engine thrust during flare.

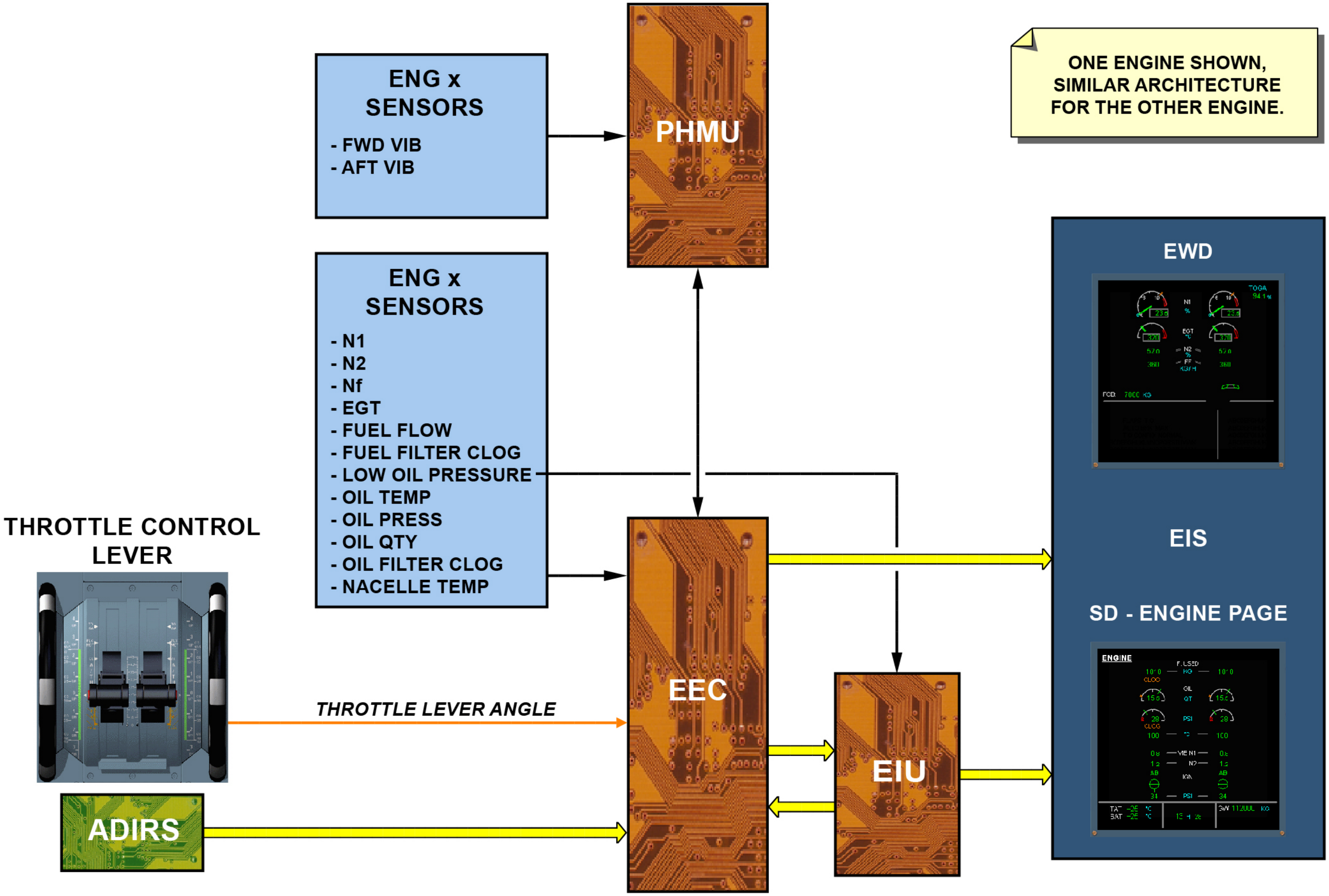


THRUST CONTROL MALFUNCTION

ENGINE MONITORING D/O (3)

INDICATING

The engine indicating system has sensors that measure some engine parameters. These parameters are supplied to the Electronic Engine Control (EEC) and / or to the Prognostic and Health Monitoring Unit (PHMU) for computation and transmission. They are sent to the Electronic Instrument System (EIS) for display on the EWD and on the SD-ENGINE Page. In conjunction with inputs from the ADIRS, they are also used to control and monitor the engine with the Throttle Lever Angle (TLA) position in manual thrust control mode or with the Engine Interface Unit (EIU) inputs in auto thrust control mode.



ENG x SENSORS
- FWD VIB
- AFT VIB
PHMU
ONE ENGINE SHOWN, SIMILAR ARCHITECTURE FOR THE OTHER ENGINE.
ENG x SENSORS
- N1
- N2
- Nf
- EGT
- FUEL FLOW
- FUEL FILTER CLOG
- LOW OIL PRESSURE
- OIL TEMP
- OIL PRESS
- OIL QTY
- OIL FILTER CLOG
- NACELLE TEMP
EWD
EIS
SD - ENGINE PAGE
THROTTLE CONTROL LEVER
THROTTLE LEVER ANGLE
EEC
EIU
ADIRS

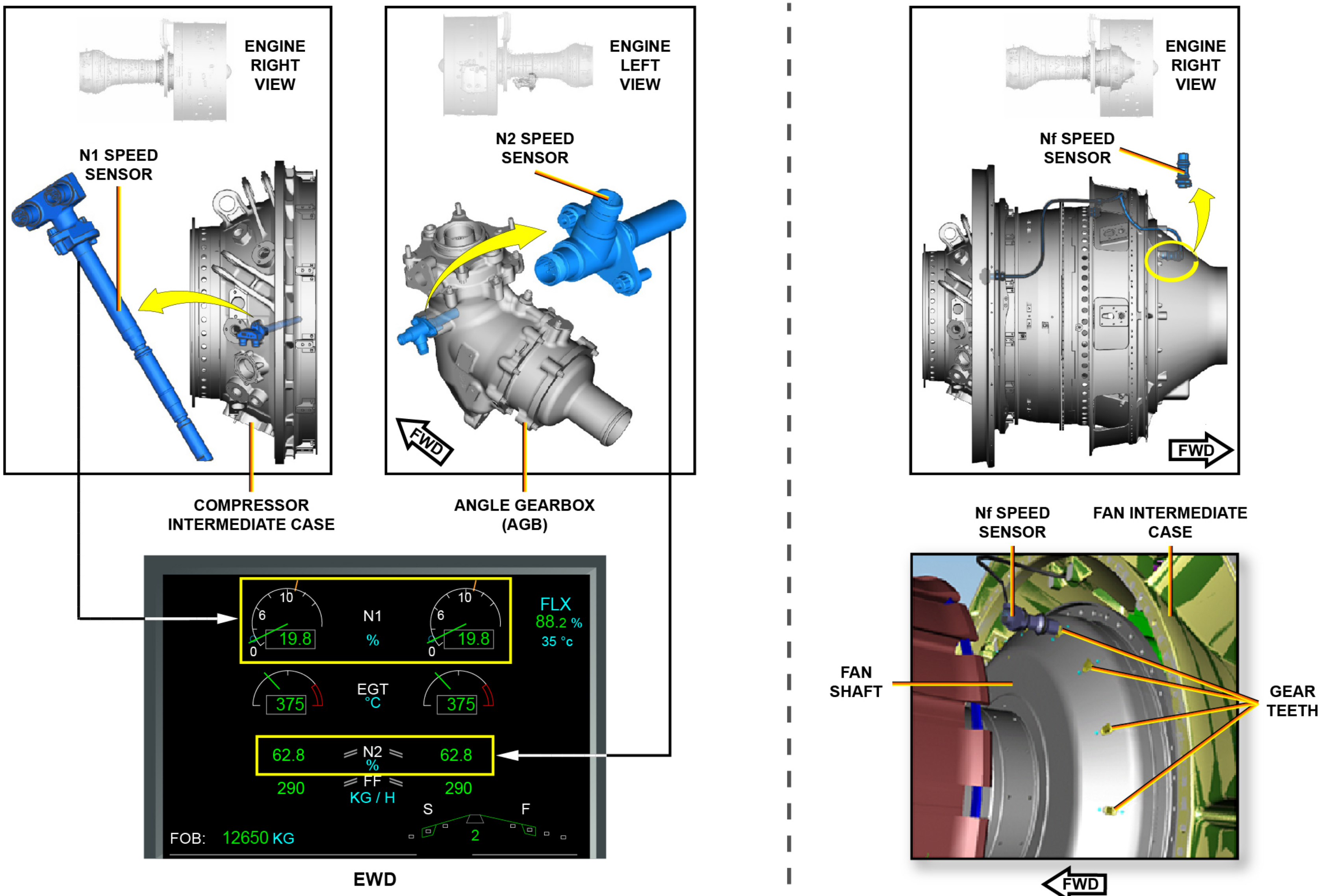
INDICATING

ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS

ROTATIONAL SPEED PARAMETERS DESCRIPTION

The N1 speed sensor is mounted on the rear of the Compressor Intermediate Case (CIC) at approximately 4 o'clock position. The N1 speed sensor detects the rotational speed of LP rotor assembly. The indication is shown in the ECAM EWD by a needle and a N1 digital indication display.
The N2 speed sensor is installed on the right hand side of the Angle Gear Box (AGB). The N2 speed sensor detects the rotational speed of the HP rotor assembly. The N2 rotational speed is indicated in the ECAM EWD by digits.
The digital display is shown on a grey background during engine start.
Both the N1 and N2 speed sensors are dual channel magnetic speed sensors and transmit the corresponding signals to the EEC for processing and monitoring and to the PHMU via the EEC for vibrations computation.
The N1 and N2 sensors are line replaceable units.
The Fan Speed (Nf) sensor senses the fan rotor speed and sends it to the EEC. There is no indication of Nf on the ECAM.
The EEC uses the Fan Speed sensor to detect de-coupling of the Fan Shaft from the LP shaft (sheared shaft) by comparing the Nf to the N1. The PHMU uses the Fan Speed from the EEC in conjunction with Fan Rotor vibrations to monitor Fan Rotor vibration and calculate trim balance solution for maintenance purposes.
The Nf sensor is a Line Replaceable Unit (LRU).



PRIMARY PARAMETERS - ROTATIONAL SPEED PARAMETERS DESCRIPTION

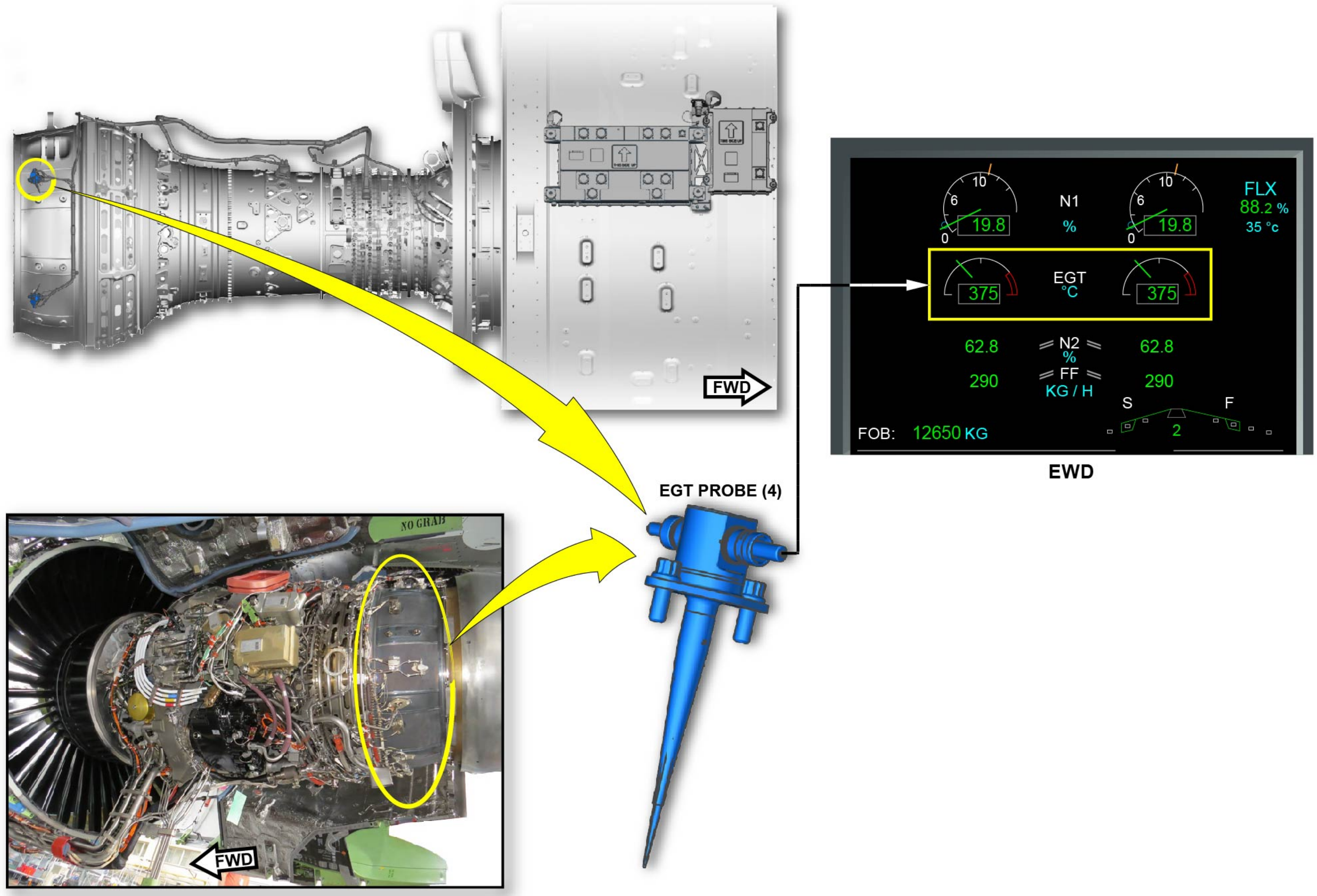
UJ515241 - U08T0MEP - UM77D2PW1100G05

ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS (continued)

EGT PARAMETERS

The engine EGT is sensed and averaged by four thermocouple probes (T5 probes) located around the circumference of the Turbine Exhaust Case (TEC). The actual engine EGT is displayed in the ECAM EWD by a needle and an EGT digital indication.
Each probe is a single channel Chromel / Alumel thermocouple. The signals from the two T5 probes on the left side of the engine are electrically averaged and sent to Channel A of the EEC. The signal from the two T5 probes on the right side of the engine are electrically averaged and sent to channel B of the EEC.
The EGT thermocouples are LRUs.



PRIMARY PARAMETERS - EGT PARAMETERS

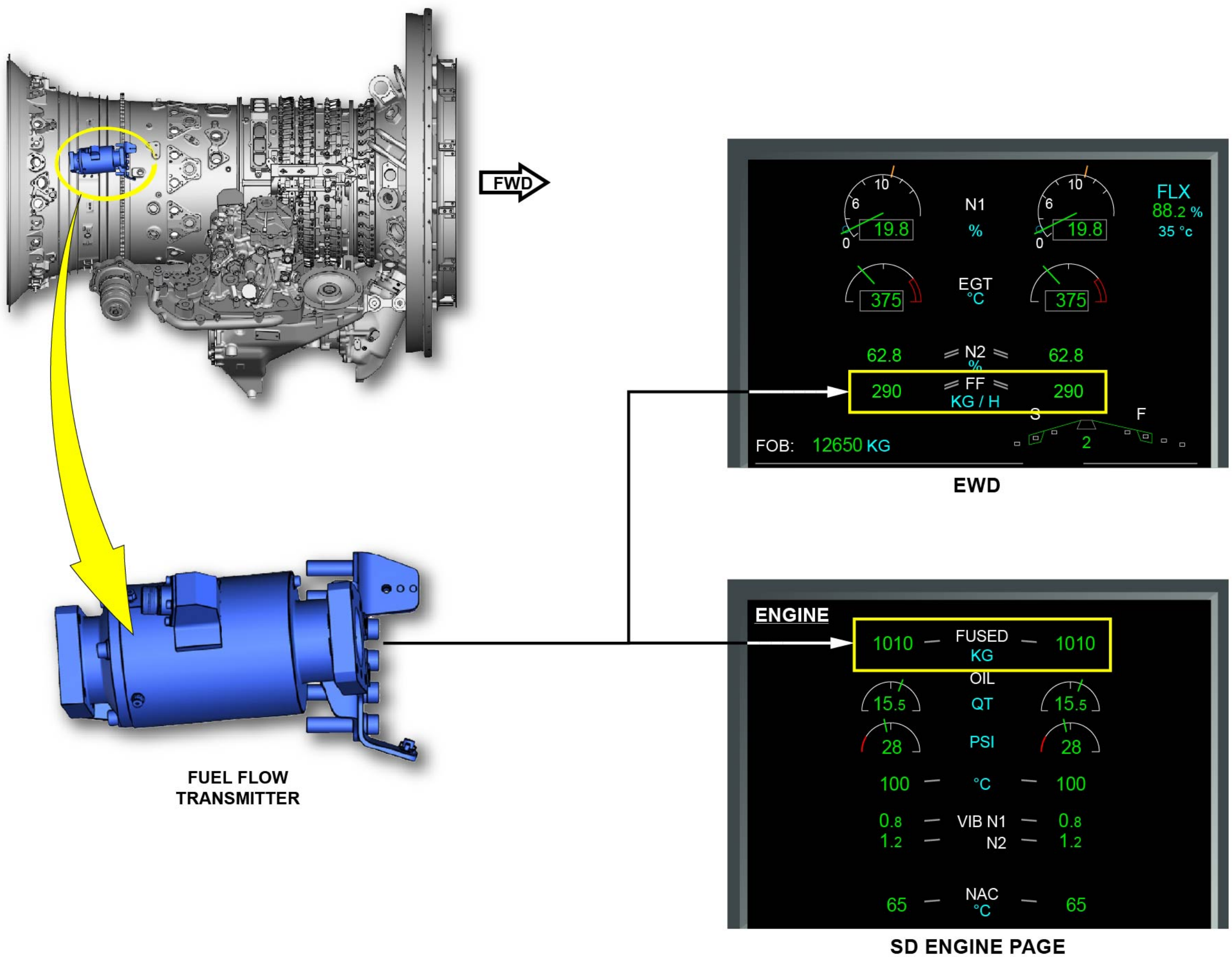
UJ515241 - U08T0MEP - UM77D2PW1100G05

ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS (continued)

FUEL PARAMETERS DESCRIPTION

The Fuel Flow Meter (FFM) is installed on the intermediate case right hand side of the engine core at approximately the 3 o'clock position. The fuel flow and the fuel used are displayed on the ECAM EWD by digital indications. The FFM is a magnetic drum and impeller type. The fuel used value is computed by the EIS from the fuel flow value sent by the EEC. The fuel used for each engine is computed from the engine start to the engine shutdown. It is reset to 0 at the next engine start.
The FFM is an LRU.



PRIMARY PARAMETERS - FUEL PARAMETERS DESCRIPTION

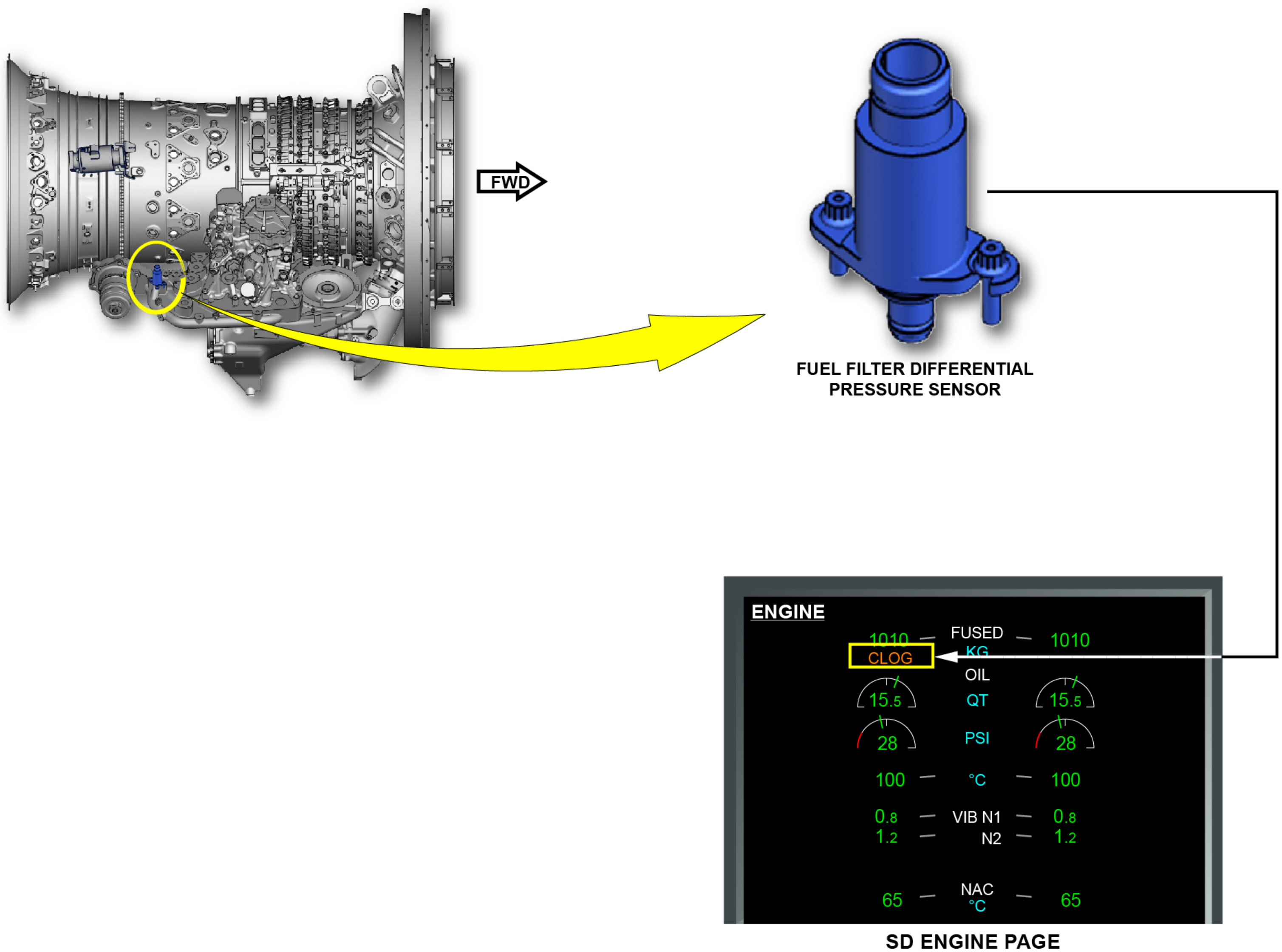
UJ515241 - U08T0MEP - UM77D2PW1100G05

ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS (continued)

FUEL PARAMETERS DESCRIPTION

The fuel filter differential pressure sensor is bolted to the fuel manifold which is attached to the Main Gearbox (MGB) at the 3 o'clock position. The sensor signal is transmitted by the EEC to the ECAM system to generate clogging alerts when the fuel differential pressure across this filter exceeds the thresholds. Two indications are available: DEGRAD or CLOG.



PRIMARY PARAMETERS - FUEL PARAMETERS DESCRIPTION

UJ515241 - U08T0MEP - UM77D2PW1100G05

ENGINE MONITORING D/O (3)

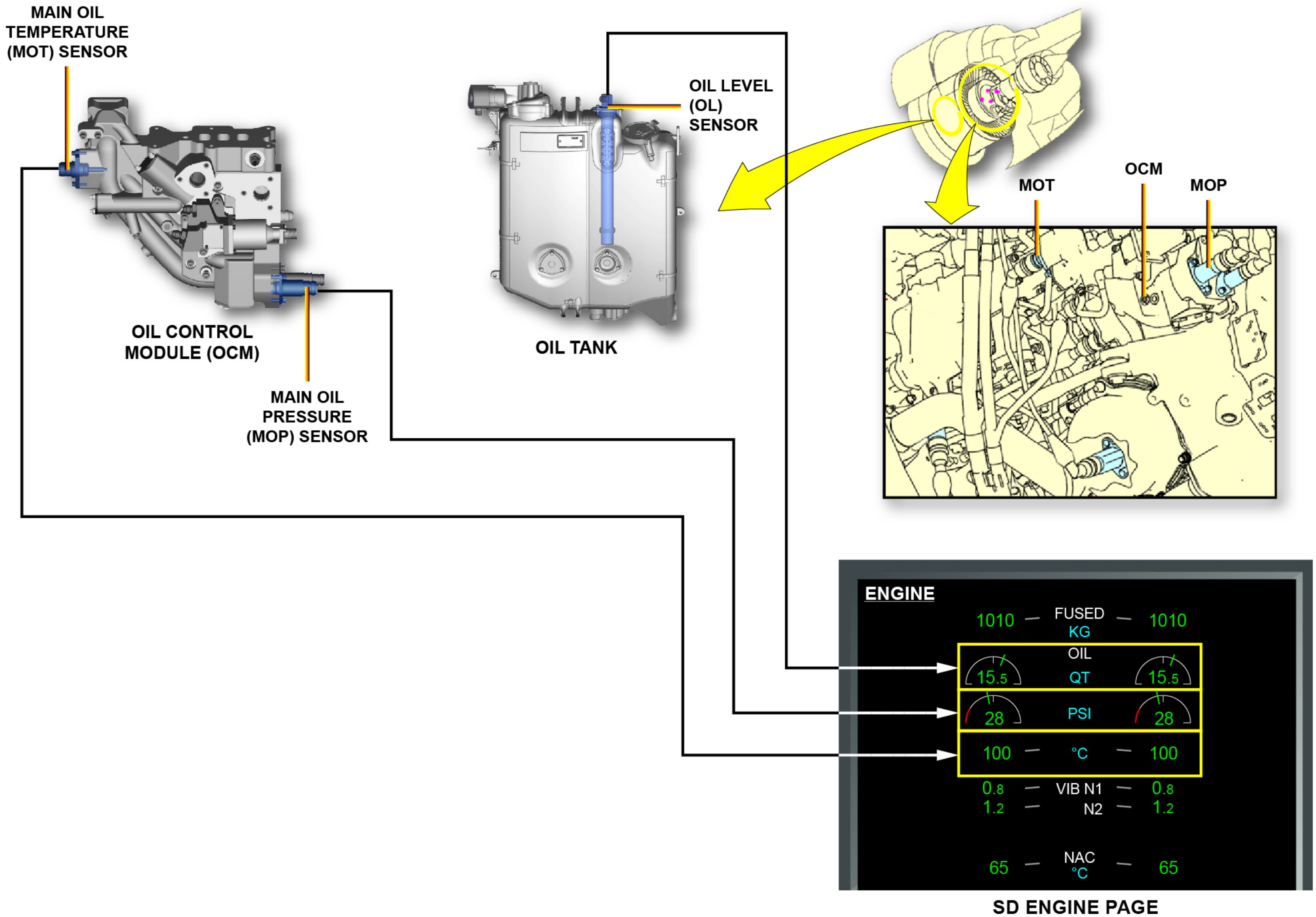
SECONDARY PARAMETERS

OIL PARAMETERS DESCRIPTION

The Oil Level (OL) sensor is located in the oil tank. It sends the oil quantity analog signal to the EEC. The EEC sends the signal for display on ECAM SD ENGINE page.
The Main Oil Pressure (MOP) sensor is located on the left hand side of the engine on the Oil Control Module (OCM), rear lower side. It is a dual channel sensor which sends the signal to the EEC for monitoring. EEC sends the signal for display on ECAM SD ENGINE page.
The Main Oil Temperature (MOT) sensor is a dual channel sensor and is used to measure the temperature of the scavenge oil returning to the tank. This data is monitored by the EEC and is displayed on the ECAM SD ENGINE page. The sensor is located on the front face of the OCM.
In case of abnormal condition, sensors send signals to trigger messages on ECAM and / or CFDS.
An Oil Filter Differential Pressure (OFDP) sensor is installed adjacent to the oil pressure filter unit on the Lubrication and Scavenge Oil Pump (LSOP) unit. The pressure sensor signal is transmitted by the EEC to the ECAM system to generate the main oil filter clogging alerts when the oil differential pressure across this filter exceeds the thresholds. Two indications are available: DEGRAD or CLOG.
An Auxiliary Oil Pressure (AOP) sensor is located on the left side of the engine, below the Variable Oil Reduction Valve /Journal Oil Shuttle Valve (VORV/JOSV). It measures the pressure of oil delivered to the journal bearings in the Fan Drive Gear System (FDGS). It sends a signal to the EEC, where it is used in conjunction with other oil parameters to detect a Fan Drive Gearbox (FDG) auxiliary oil supply malfunction.

The Low Oil Pressure (LOP) switch signals the EIU when the oil pressure drops below a threshold. It is located on the left hand side of the engine on the Oil Control Module (OCM).
The Oil Debris Monitoring (ODM) sensor is located on the top front side of the oil tank. It sends signals proportional to size and type of the pollution particles to the PHMU. The PHMU monitors the debris for quantity and identifies whether it is ferrous or non-ferrous debris. The data is transmitted to the EEC for analysis and to generate an ECAM message and trend monitoring accordingly. The data is also stored in the Data Storage Unit (DSU).

UJ515241 - U08T0MEP - UM77D2PW1100G05



SECONDARY PARAMETERS - OIL PARAMETERS DESCRIPTION

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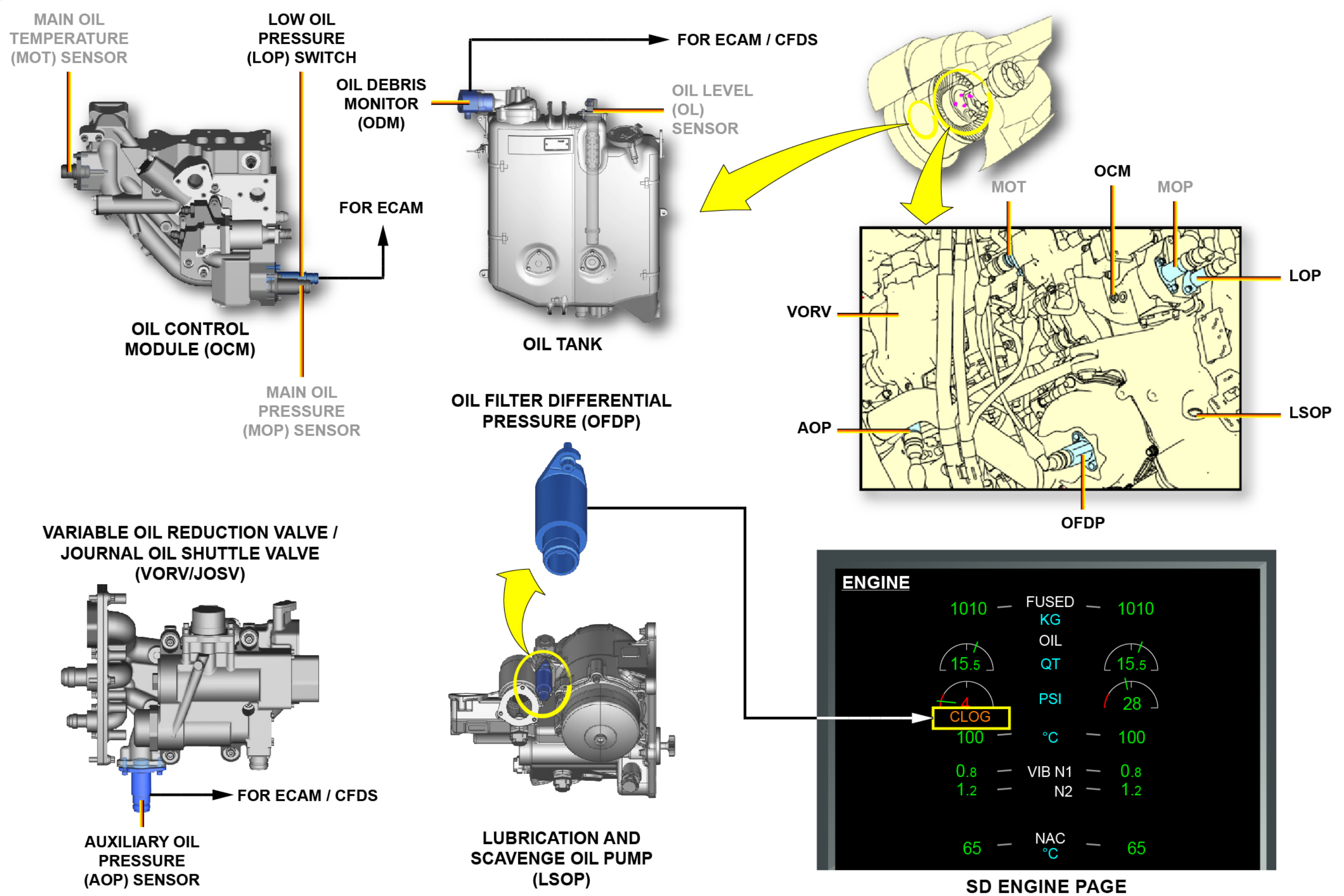

SECONDARY PARAMETERS - OIL PARAMETERS DESCRIPTION

UJ515241 - U08T0MEP - UM77D2PW1100G05

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ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

VIBRATION PARAMETERS DESCRIPTION

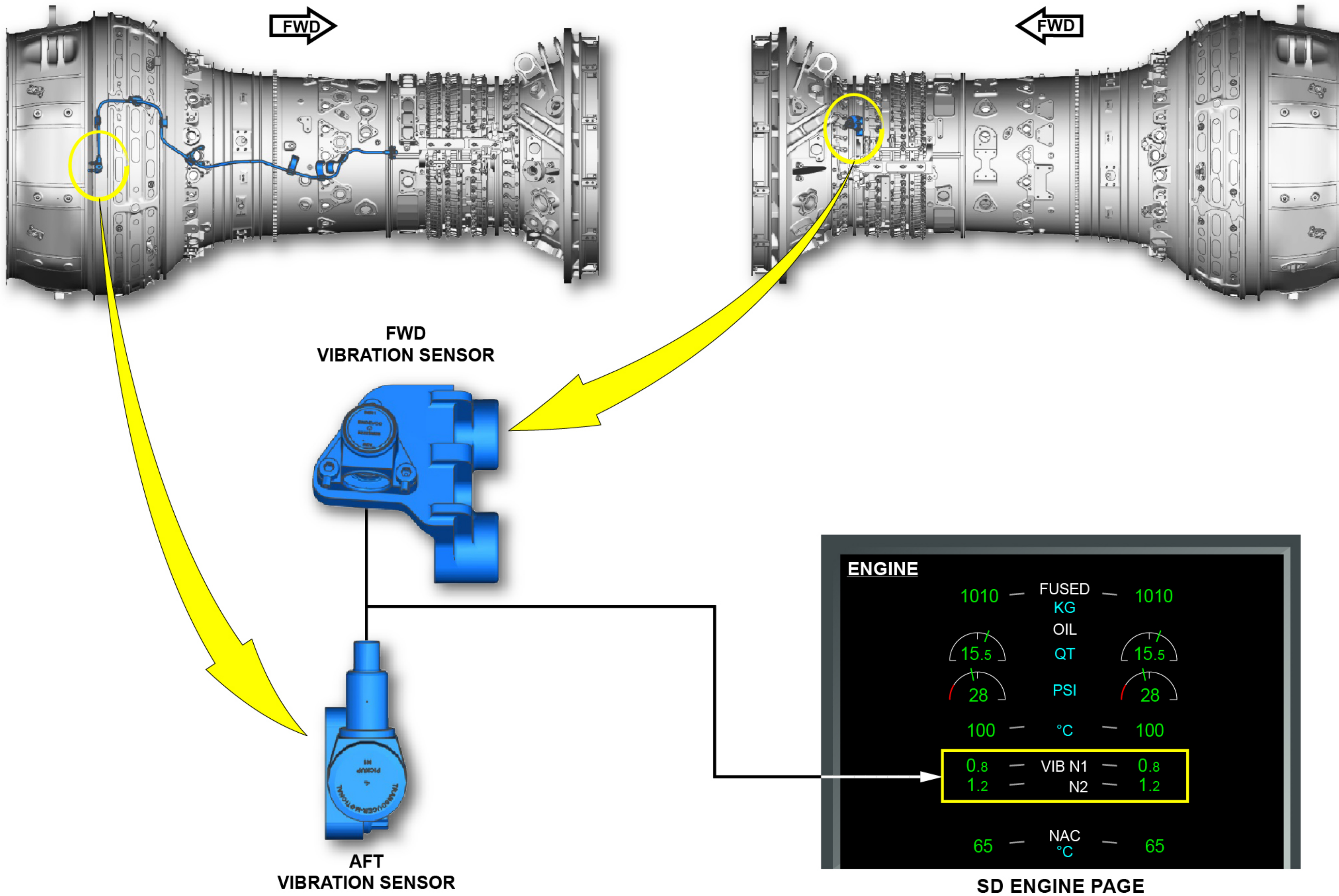
The vibration monitoring function within the PHMU uses the two vibration sensors to measure the Fan related vibrations (VIB N1) and the Core related vibrations (VIB N2), stores this information and sends it to the EEC. It is used for ECAM display in the ENGINE SD page. It's also used for the fan trim balance procedure.

The PHMU receives Nf, N1 and N2 data from EEC to capture and compute the appropriate vibration data.

The Forward Vibration Sensor is a single channel piezoelectric accelerometer, installed at 10 o'clock on the HP Compressor casing.

The Aft Vibration Sensor is a single channel piezoelectric accelerometer, installed at 3 o'clock on the LP Turbine casing.

If the signal from one vibration sensor (either forward or aft vibration sensor) is lost during engine operation, the vibration monitoring function is still able to provide both vibration signals (N1 and N2) for cockpit display. However, the display for the affected sensor will be presented in degraded mode.



SECONDARY PARAMETERS - VIBRATION PARAMETERS DESCRIPTION

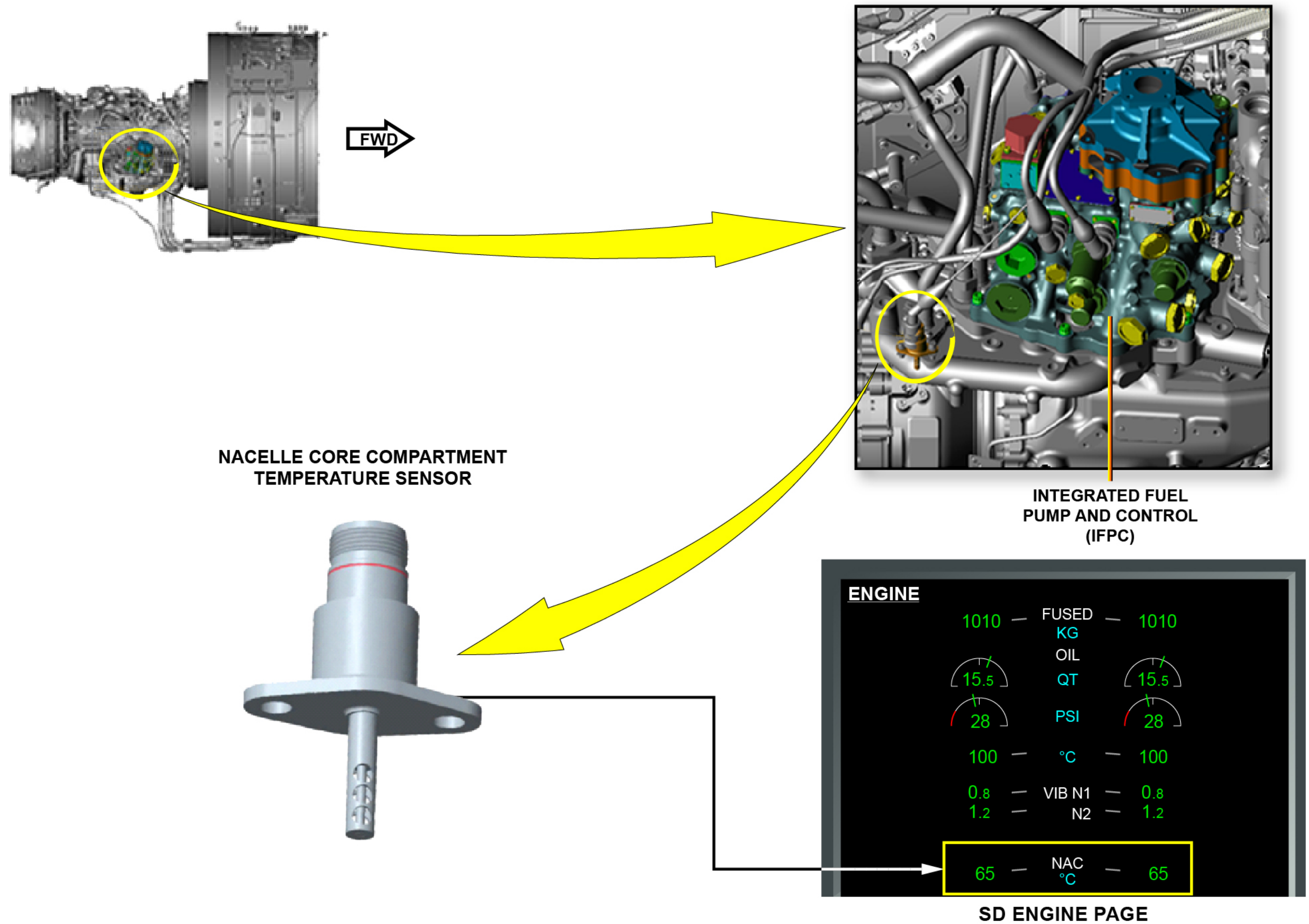
UJ515241 - U08T0MEP - UM77D2PW1100G05

ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

NACELLLE TEMPERATURE INDICATION

The nacelle temperature is monitored by a temperature probe installed in the ventilated core compartment.
The nacelle temperature is displayed on the ECAM ENGINE SD, except during starting or cranking sequences where it is replaced by starting parameters.

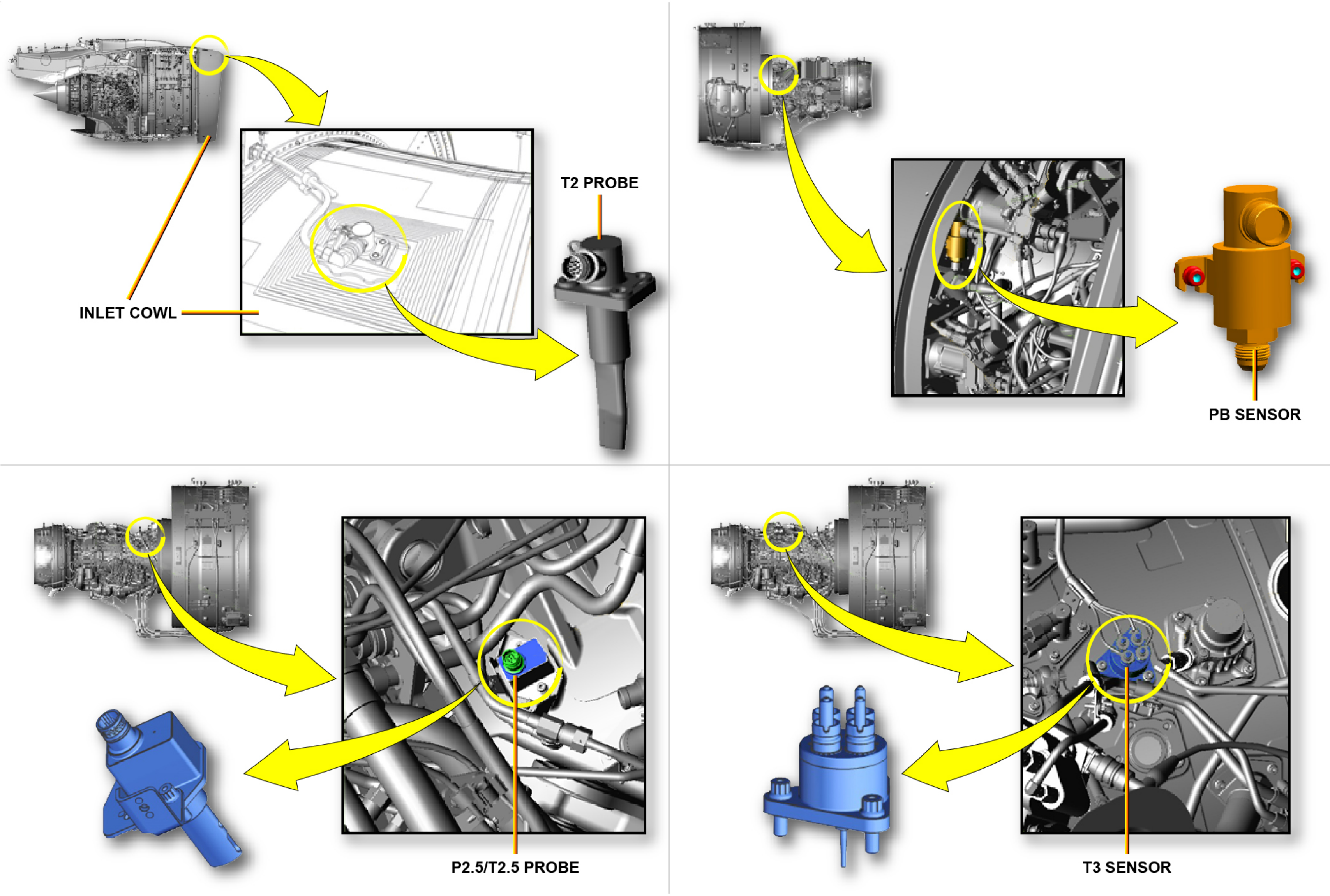


SECONDARY PARAMETERS - NACELLLE TEMPERATURE INDICATION

ENGINE MONITORING D/O (3)

OTHER SENSORS FOR ENGINE CONTROL AND MONITORING

Various sensors are used by the EEC for the engine control and monitoring.
The T2 sensor measures the air inlet temperature for engine rating, Mach number calculation and bleed scheduling. It is located in the air inlet cowl at 1 o'clock position.
The P 2.5/T 2.5 sensor measures the air pressure and temperature downstream of the booster at the High Pressure Compressor (HPC) inlet. It is located on the Compressor Intermediate Case at 1 o'clock position.
The Burner Pressure (PB) sensor measures the pressure related to the combustion for fuel scheduling, surge recovery, stall detection, idle modulation and continuous ignition logic. It is located in the LH side Compressor Intermediate case firewall at 11 o'clock position.
The T3 sensor measures the compressor discharge temperature for total temperature calculation. It is located on the diffuser case, forward of the fuel nozzles at 1 o'clock position.



OTHER SENSORS FOR ENGINE CONTROL AND MONITORING

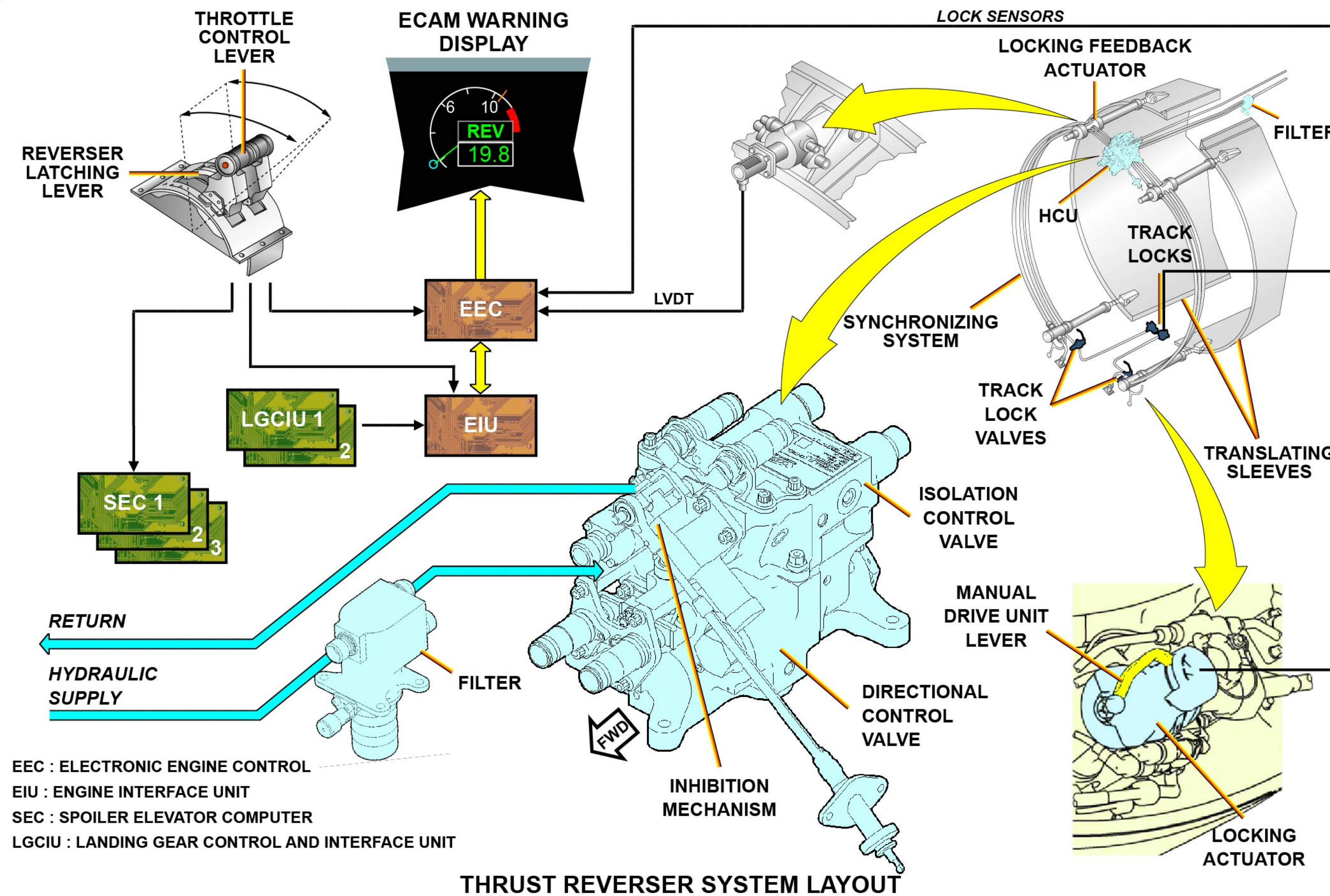
UJ515241 - U08T0MEP - UM77D2PW1100G05

THRUST REVERSER D/O (3)

THRUST REVERSER SYSTEM LAYOUT

The thrust reverser system is of the aerodynamic blockage type.
For each engine, it consists of two translating sleeves, ten blocker doors and cascade vanes to redirect fan discharge airflow.
Each system is pressurized by its dedicated hydraulic power source:
- the green hydraulic pressure for engine 1,
- and the yellow one for engine 2.

Each system is made of one Hydraulic Control Unit (HCU) including an Isolation Control Valve (ICV) and a Directional Control Valve (DCV), two worm drive actuators per side, locking and monitoring devices.
To avoid inadvertent deployment, the system operates under multiple and independent commands and it comprises several lines of defense: primary locks in each actuator and one tertiary lock at the bottom of each translating sleeve.



THRUST REVERSER SYSTEM LAYOUT

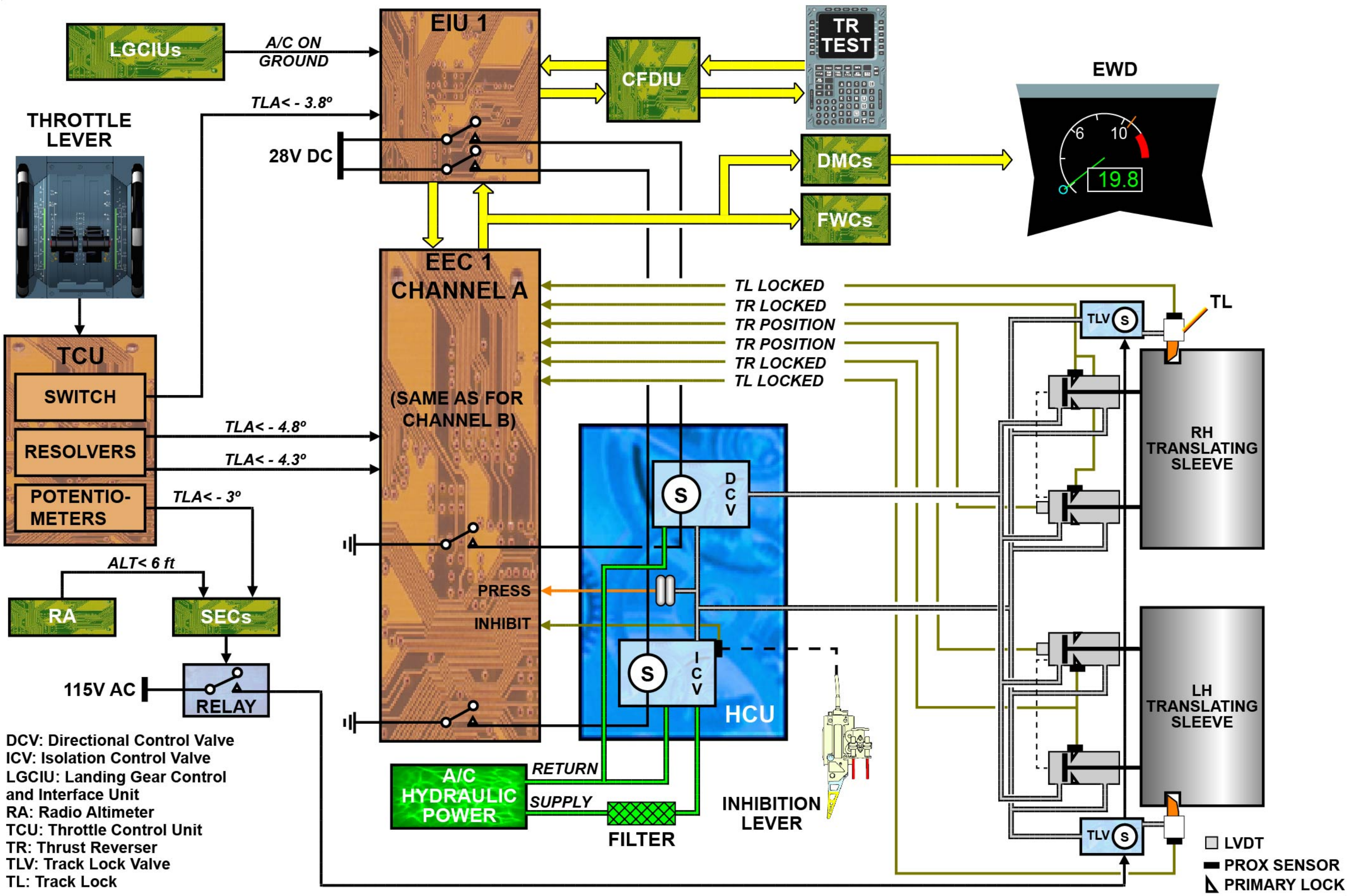
UJ515241 - U08T0MEP - UM78D1PW1100G05

THRUST REVERSER D/O (3)

DEPLOY SEQUENCE

The EEC confirms the engine is running. The thrust reversers are stowed, locked and not inhibited.
In these conditions:
- the ICV, DCV, Track Lock Valves (TLV) are de-energized to prevent pressurization,
- the 6 proximity sensors indicate locked,
- the ICV pressure switch indicates a low pressure,
- both LVDTs indicate a stowed condition,
- the HCU inhibition lever proximity sensor indicates a non-inhibited condition.

When the thrust-reverser lever is set to the deploy position, the following sequence occurs.
1-As soon as the Spoiler Elevator Computers (SECs) receive the signal from the TCU potentiometers (Throttle Lever Angle (TLA) < -3°), and from the Radio Altimeter (RA) (altitude < 6 ft), they control the powering of the TLVs to open. In this position, the TLVs are ready to let the hydraulic pressure release the Track Lock (TL) when the ICV will be controlled open.
2-When the Engine Interface Unit (EIU) receives the signals from the Throttle Control Unit (TCU) switch (TLA < -3.8°) and from the Landing Gear Control and Interface Units (LGCIUs) (aircraft on ground), it controls the closure of internal relays involved in the ICV and DCV powering.
3-When the Electronic Engine Control (EEC) receives the signals from the TCU resolvers (TLA < -4.3°), it closes an internal relay to power the ICV to open. The pressure is sent to the actuators rod chambers to perform an overstow and to the TLs to release the latches.
4- When the EEC receives the signals from the TCU resolvers (TLA < -4.8°) provided the TLs are confirmed unlocked, it closes an internal relay to power the DCV to open. The pressure is sent to the actuators jack heads to release the actuators internal primary locks and command the translating sleeves deployment.
5-Above 85 % of travel, the EEC commands the engine to accelerate from reverse idle to max reverse thrust. Maximum allowable thrust is defined as a function of sleeve travel and TLA.
At 95% of travel, the actuators engage their integral snubbing devices, thus decreasing their extension speed before the full opening.
The TLV, ICV and DCV remain supplied to maintain the translating sleeves fully deployed by hydraulic pressure.



DEPLOY SEQUENCE

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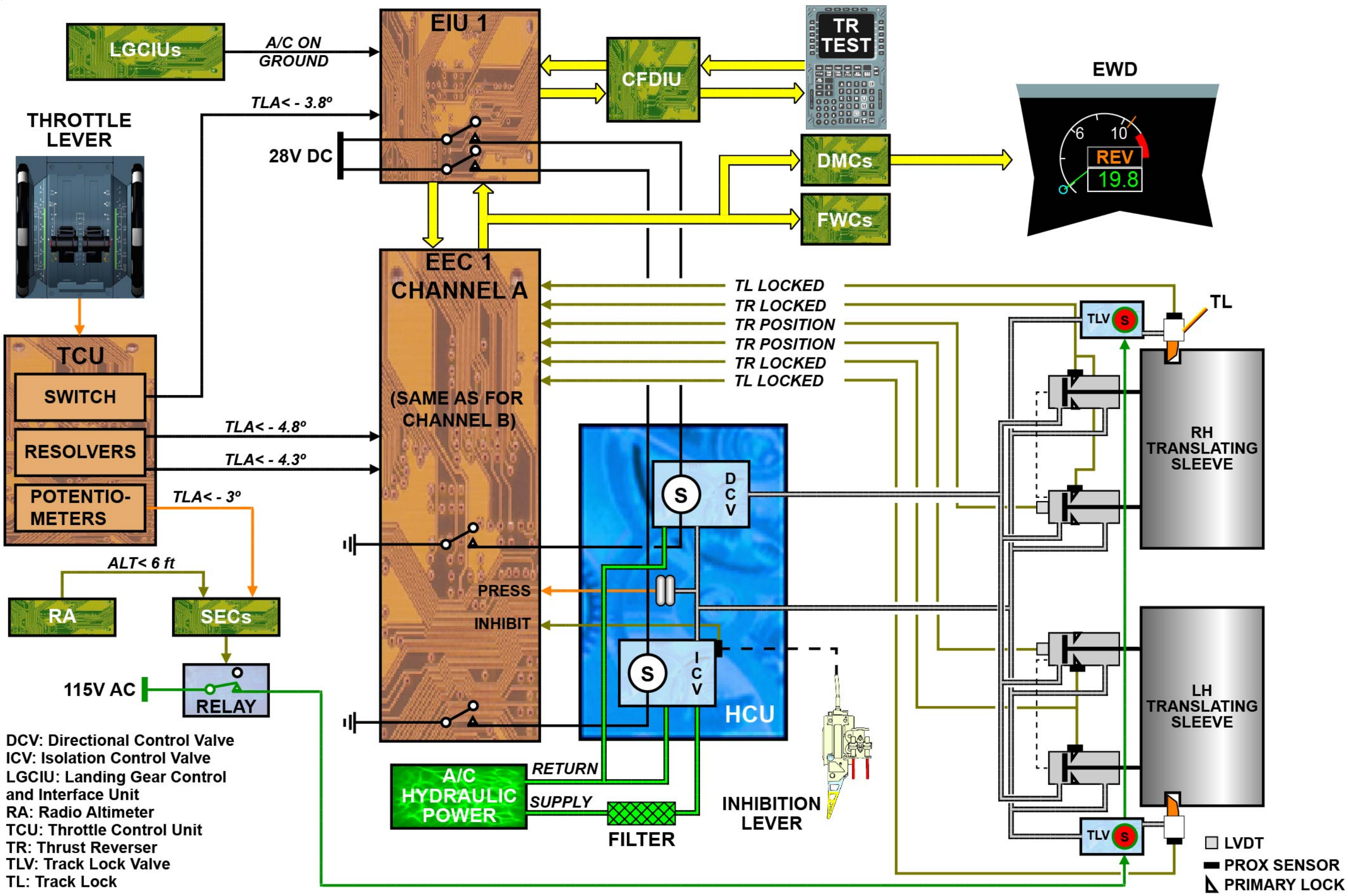

DEPLOY SEQUENCE

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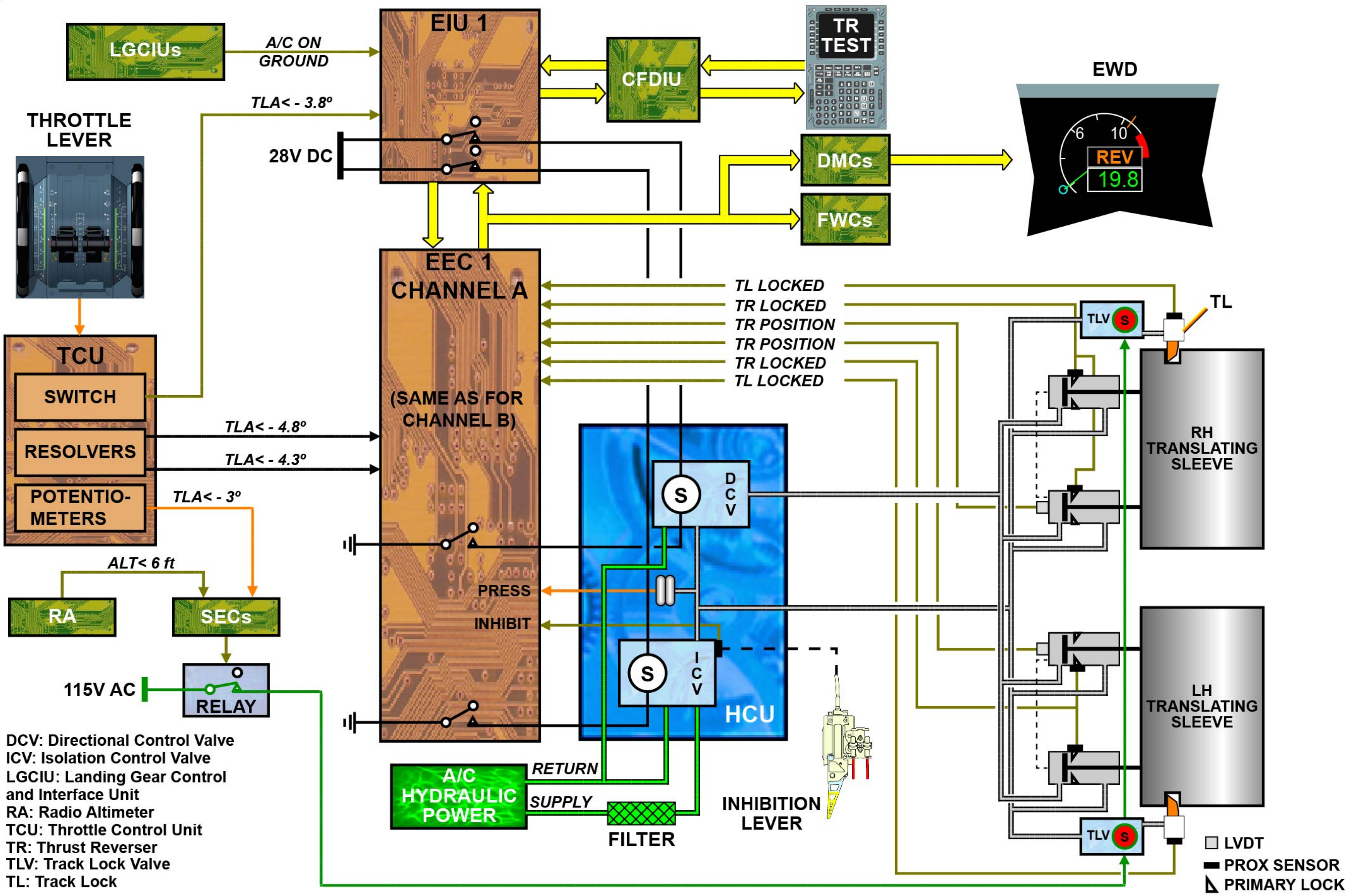
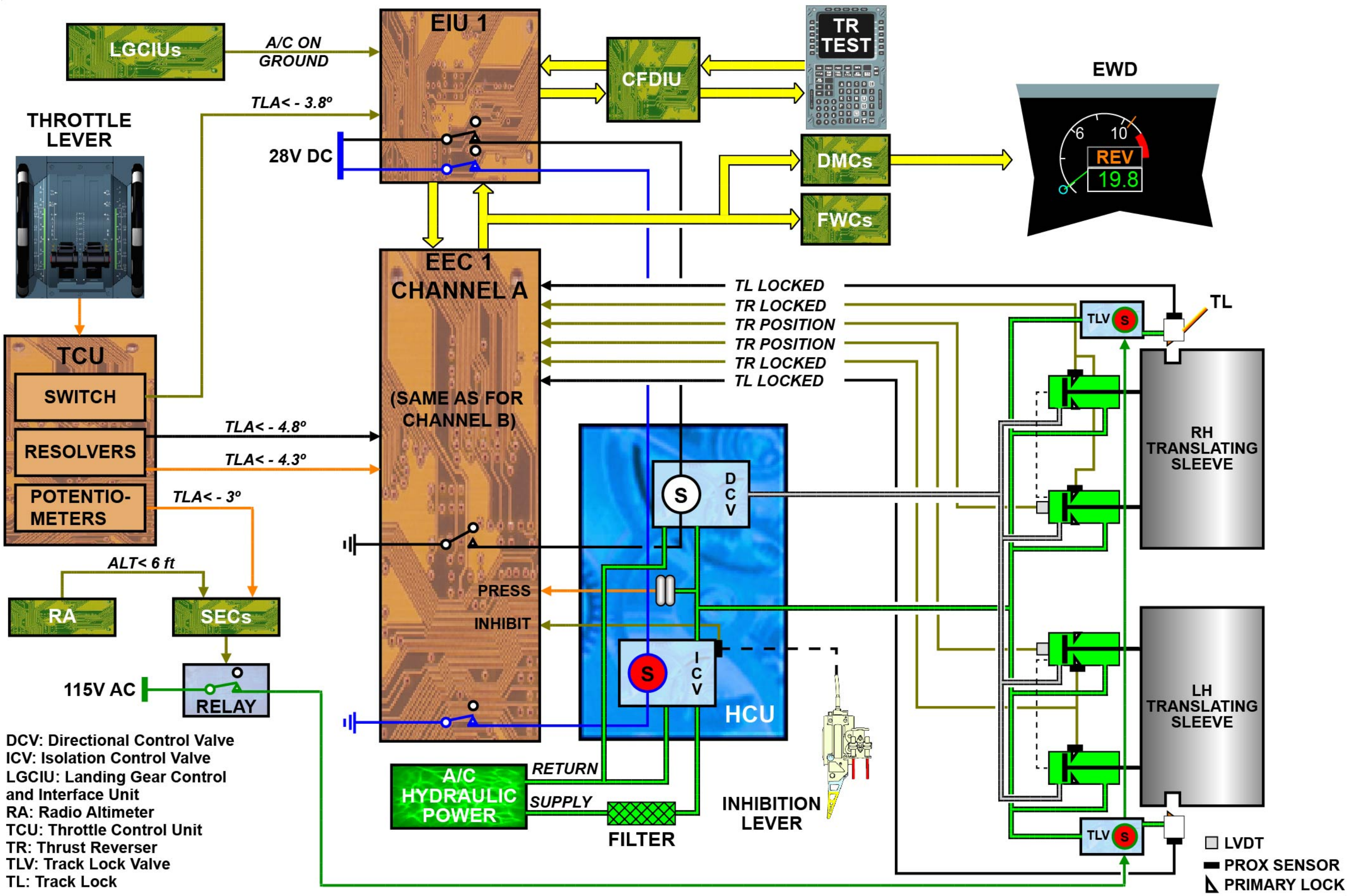


DCV: Directional Control Valve
ICV: Isolation Control Valve
LGCIU: Landing Gear Control and Interface Unit
RA: Radio Altimeter
TCU: Throttle Control Unit
TR: Thrust Reverser
TLV: Track Lock Valve
TL: Track Lock

DEPLOY SEQUENCE

UJ515241 - U08T0MEP - UM78D1PW1100G05



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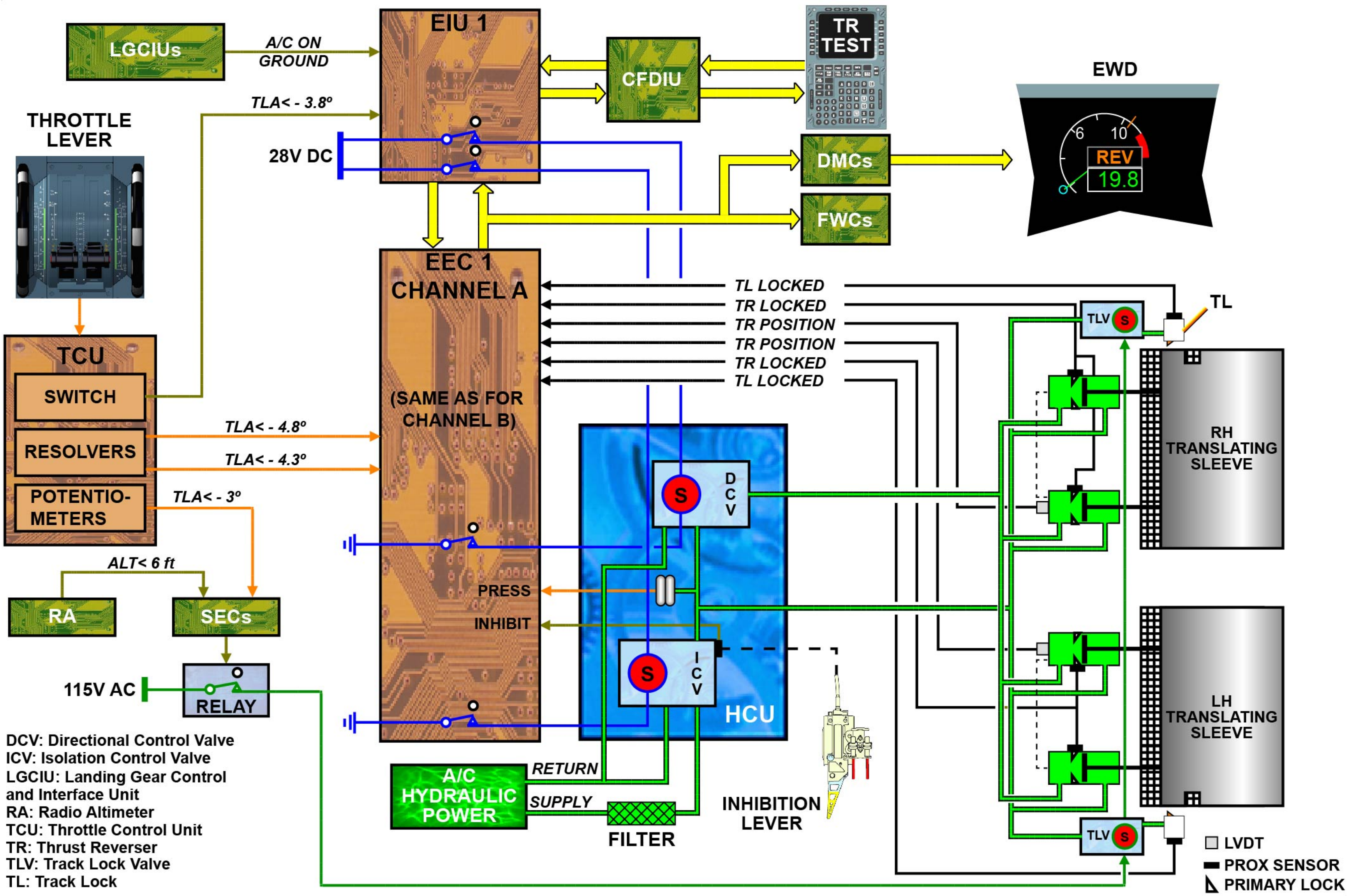
DEPLOY SEQUENCE

UJ515241 - U08T0MEP - UM78D1PW1100G05



DEPLOY SEQUENCE

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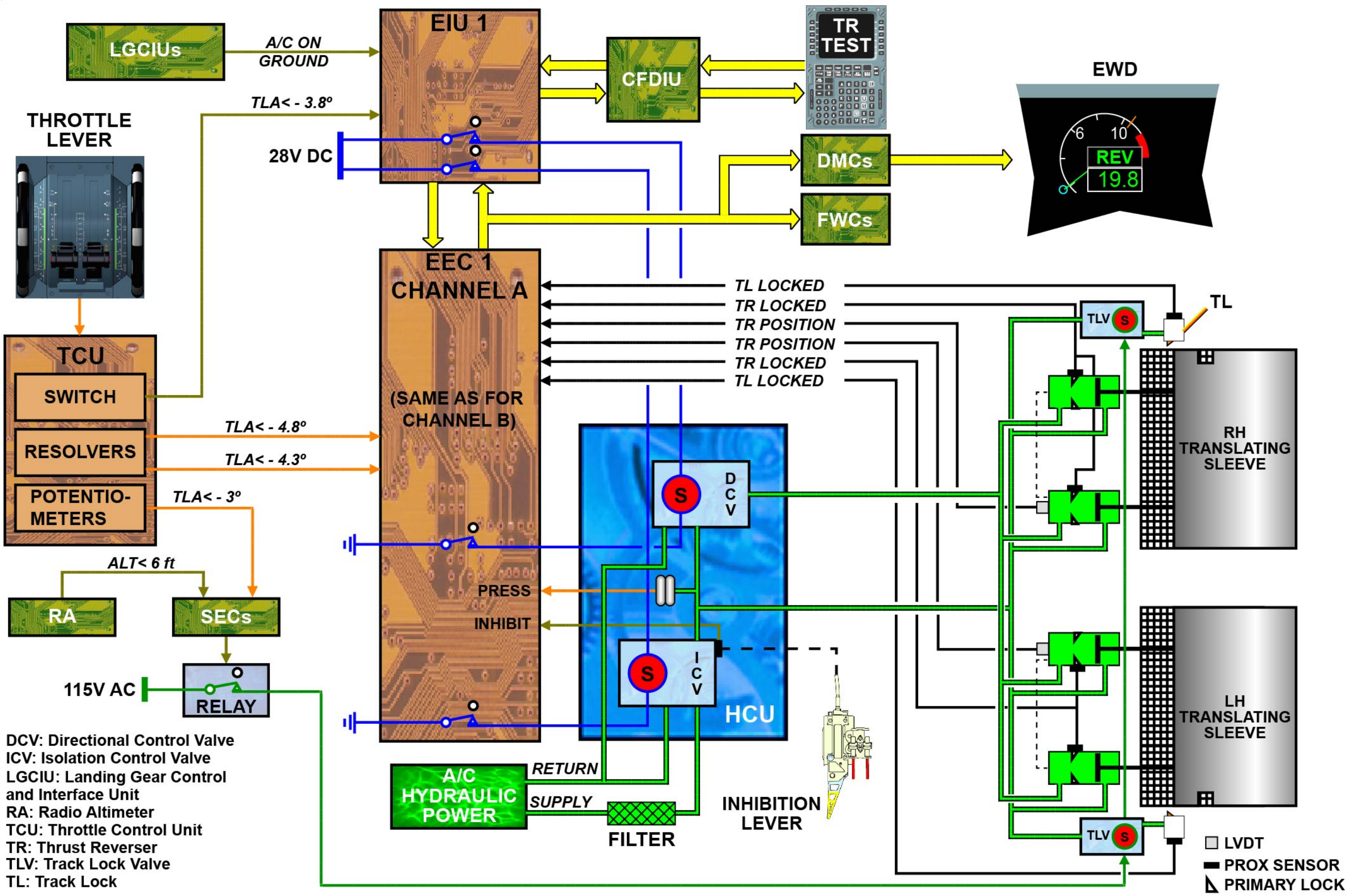

DEPLOY SEQUENCE

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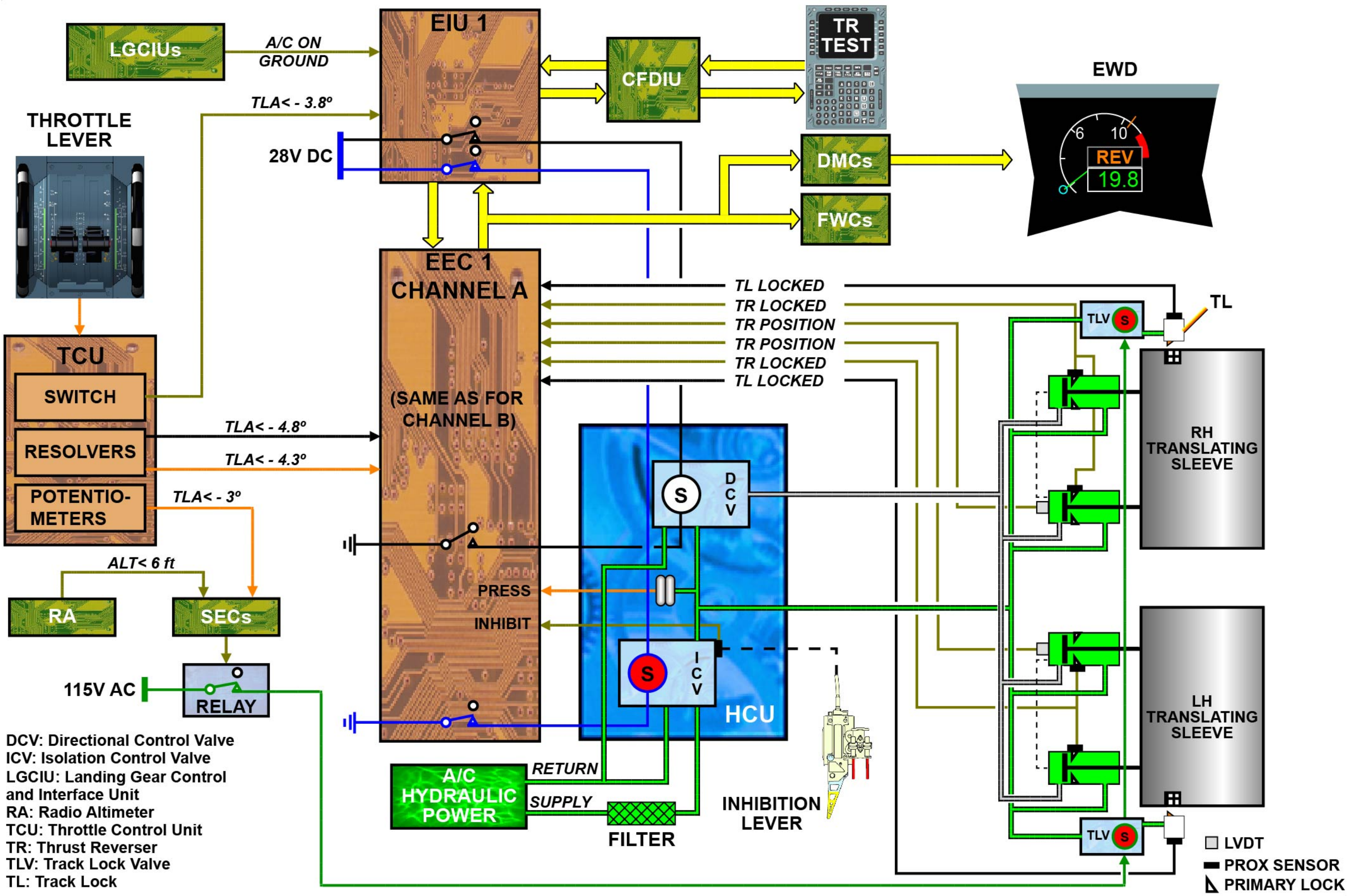
THRUST REVERSER D/O (3)

STOW SEQUENCE

When the thrust-reverser lever is set to the stow position, the following sequence occurs.
1-When the EEC receives the signals from the TCU resolvers (TLA > -4.8°), it de-energizes the DCV. The pressure is sent only to the actuators rod chambers to stow the translating sleeves until the actuators internal primary locks are re-engaged.
2-15 seconds after the SECs receive the signals from the TCU potentiometers (TLA > -2°), they de-energize the TLVs to re-engage the TLs.
3-15 seconds after the stow sequence is completed, the EEC de-energizes the ICV. Then the EIU opens its internal relays to isolate the ICV and DCV powering.



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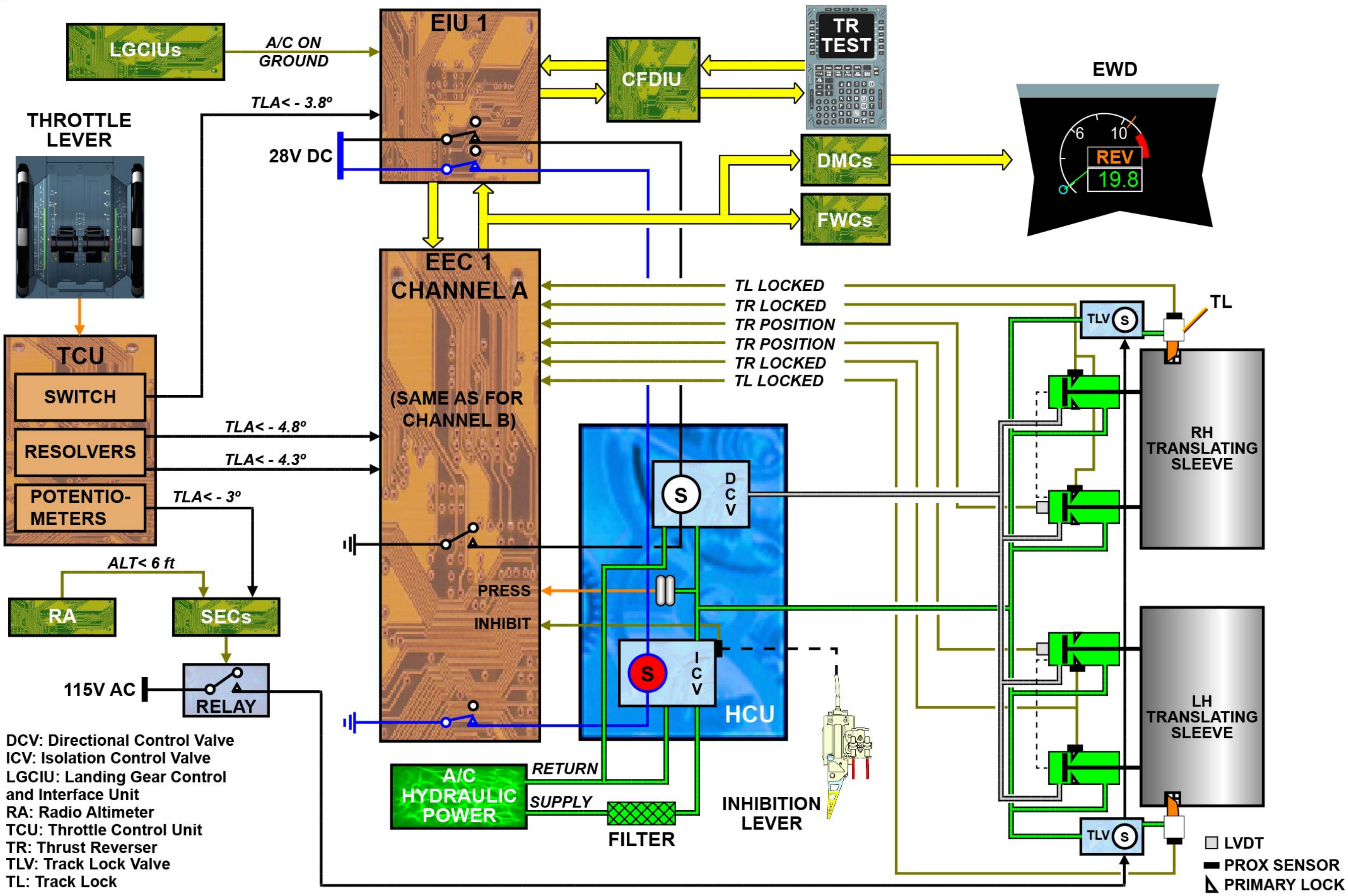
STOW SEQUENCE



STOW SEQUENCE

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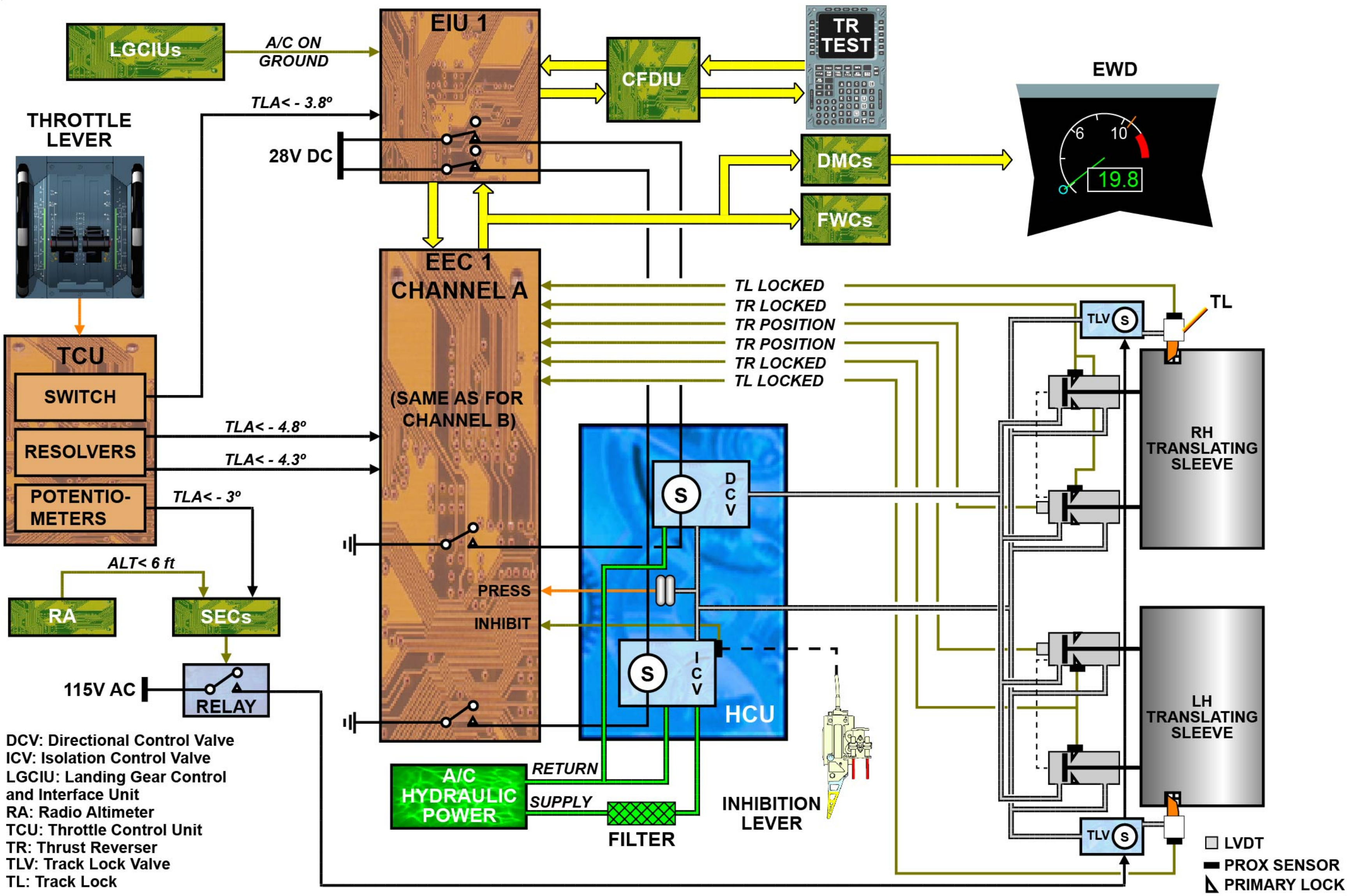


STOW SEQUENCE

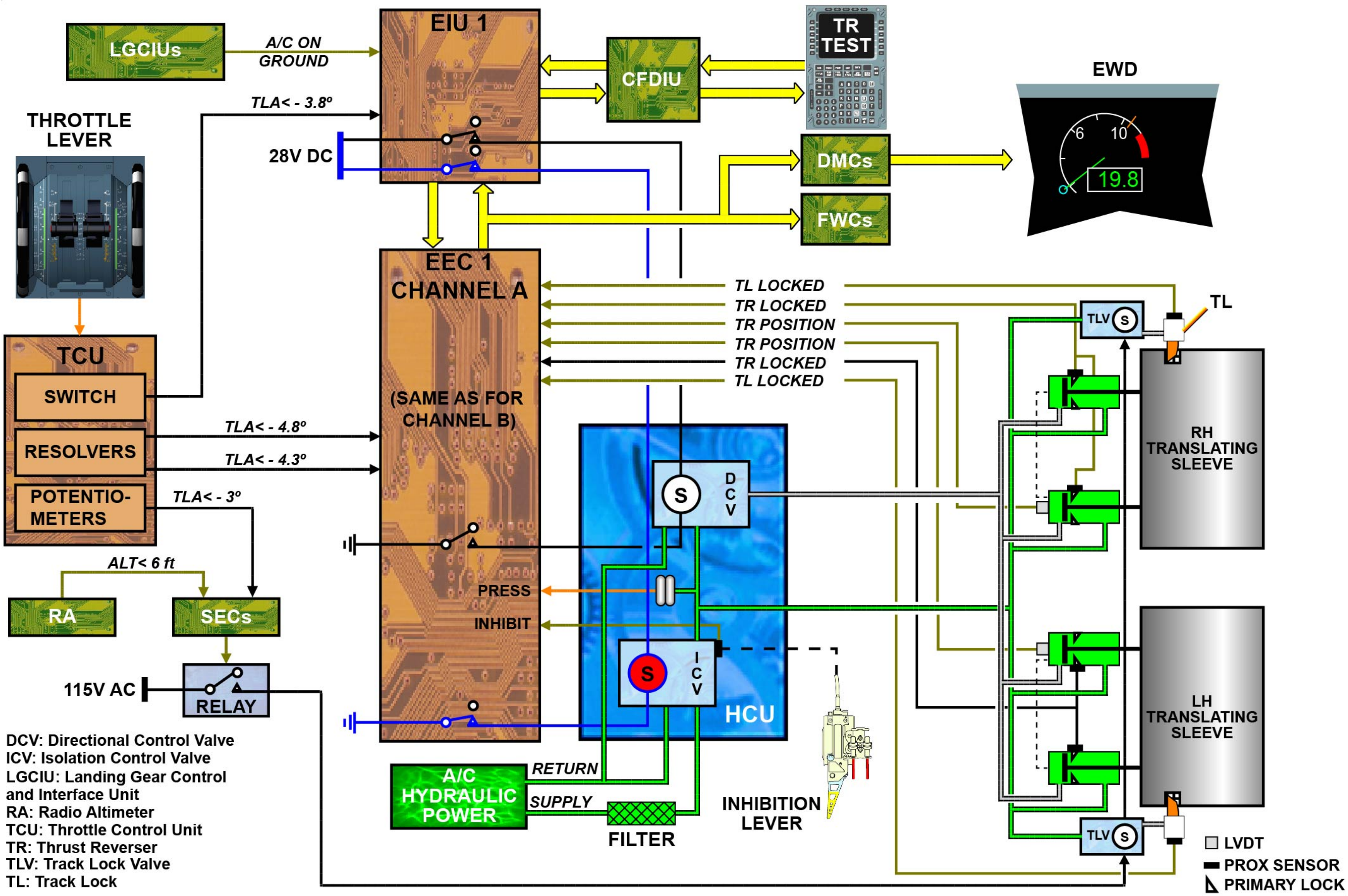
UJ515241 - U08T0MEP - UM78D1PW1100G05

THRUST REVERSER D/O (3)

GROUND ASSISTED STOW SEQUENCE (GASS)

The EEC shall initiate a thrust reverser GASS operation on ground only in order to lock the thrust reverser system in the following two cases:
- at least one primary lock is detected unlock after the normal stow sequence is completed (operational case),
- if at least one primary lock is detected unlock after the engine start (maintenance case).

The GASS shall be initiated by energizing the ICV for 5 seconds when all the following conditions are fulfilled:
- the aircraft is on ground,
- the throttle is in forward thrust region and less than CL position,
- no stow sequence is being commanded,
- within 15s after engine transition to idle following an engine start,
- one or two primary locks of any translating sleeve are seen unlocked,
- the sleeve positions (left and right) are less than 5% of travel,
- the thrust reverser is not inhibited,
- 28V DC power is available.



DCV: Directional Control Valve
ICV: Isolation Control Valve
LGCIU: Landing Gear Control and Interface Unit
RA: Radio Altimeter
TCU: Throttle Control Unit
TR: Thrust Reverser
TLV: Track Lock Valve
TL: Track Lock

UJ515241 - U08T0MEP - UM78D1PW1100G05

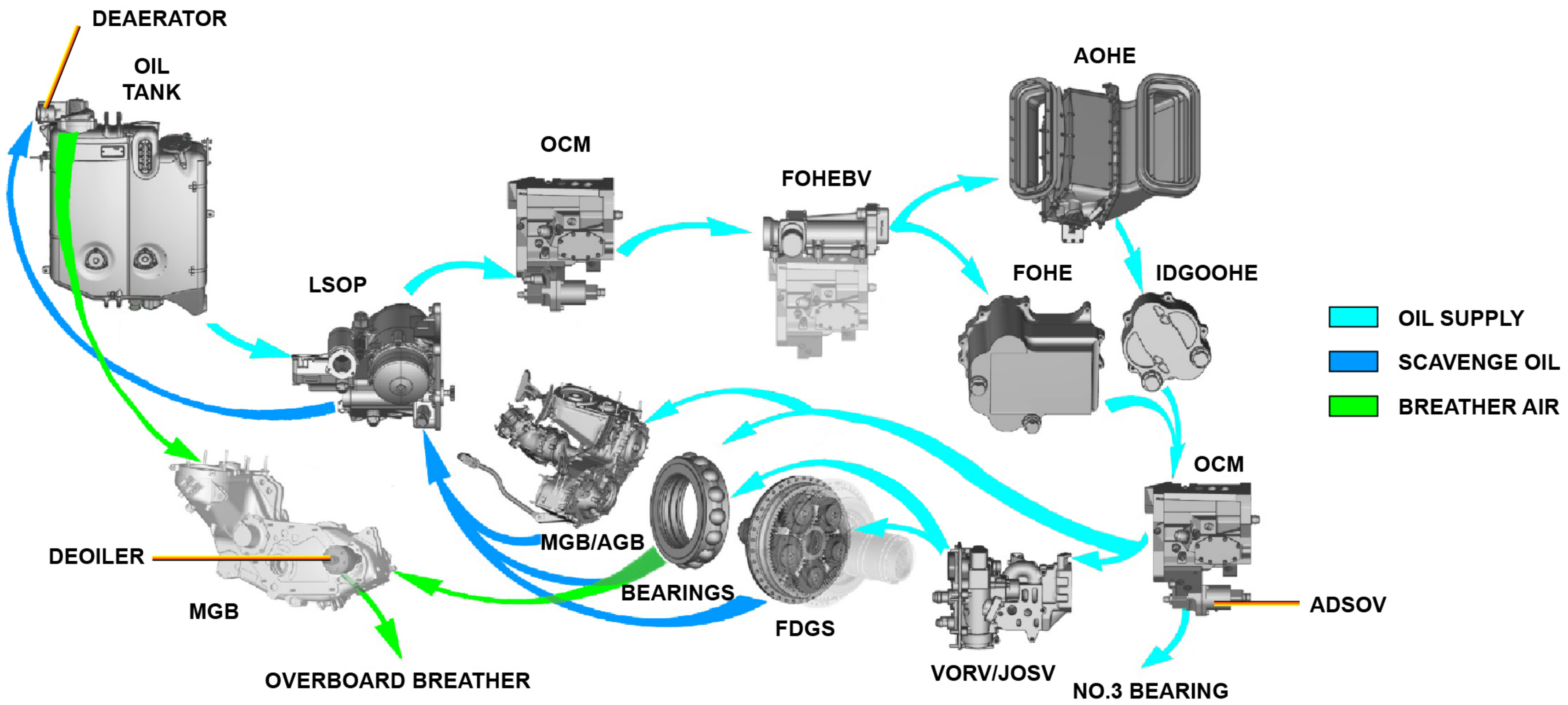
GROUND ASSISTED STOW SEQUENCE (GASS)

OIL SYSTEM D/O (3)

OIL SYSTEM LAYOUT

The oil system:
- Lubricates the engine bearings, Angle Gearbox (AGB), Main Gearbox (MGB) and Fan Drive Gear System (FDGS) with filtered, non-pressure regulated oil,
- Regulates the temperature of the engine oil with the Air/Oil Heat Exchanger (AOHE), engine fuel with the Fuel/Oil Heat Exchanger (FOHE), Integrated Drive Generator (IDG) oil with IDG Oil/Oil Heat Exchanger (IDGOOHE),
- Scavenges the hot lubrication oil back to the tank,
- Vents overboard the excess of sealing air from the bearing compartments.

OIL SYSTEM LAYOUT



ADSOV: Active Damper Shutt Off Valve
AGB: Angle Gearbox
AOHE: Air/Oil Heat Exchanger
FDGS: Fan Drive Gear System
FOHE: Fuel/Oil Heat Exchanger
FOHEBV: FOHE Bypass Valve
IDGOOHE: IDG Oil/Oil Heat Exchanger
JOSV: Journal Oil Shuttle Valve
LSOP: Lubrication and Scavenge Oil Pump
MGB: Main Gearbox
OCM: Oil Control Module
VORV: Variable Oil Reduction Valve

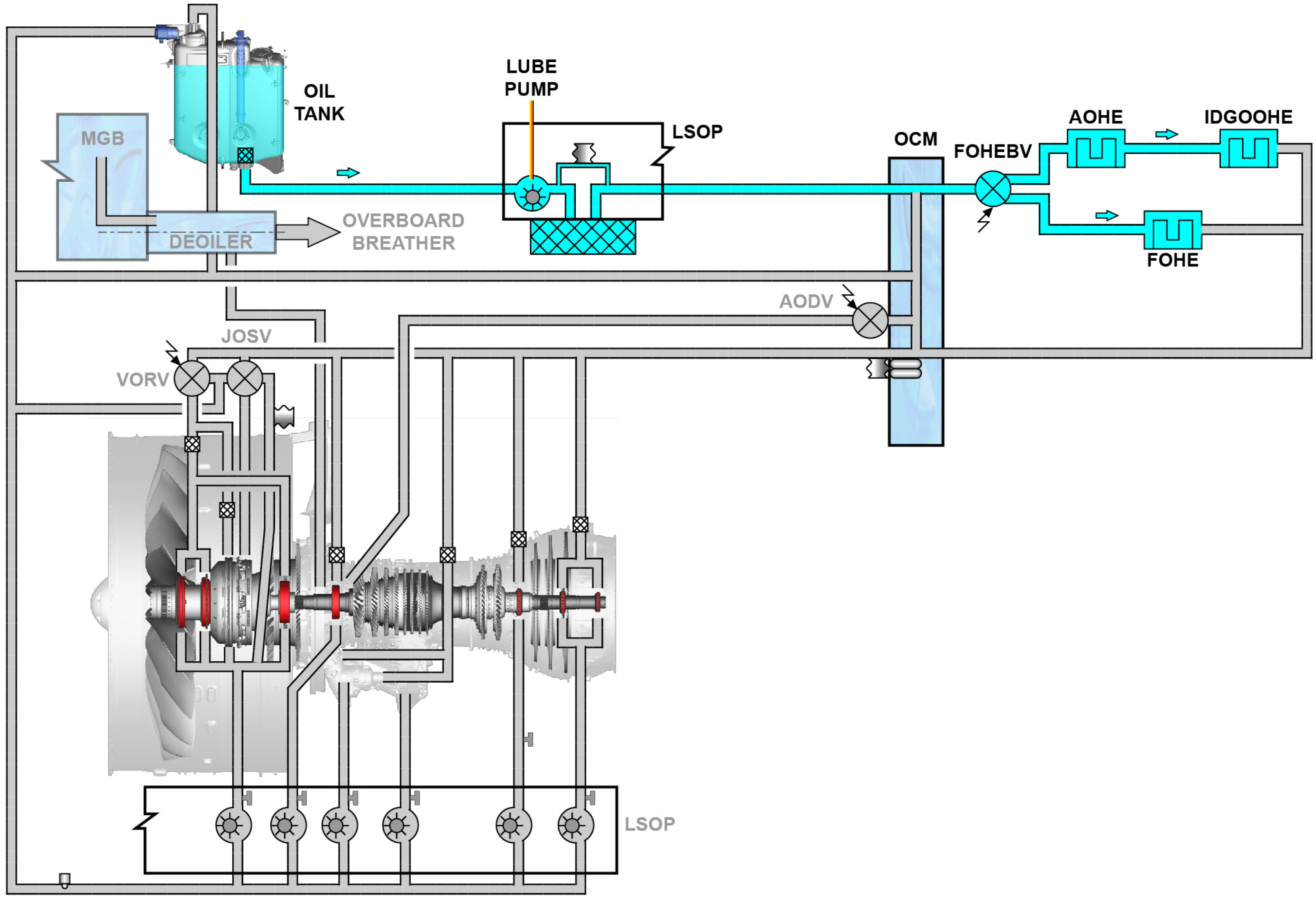
OIL SYSTEM LAYOUT

UJ515241 - U08T0MEP - UM79D1PW1100G05

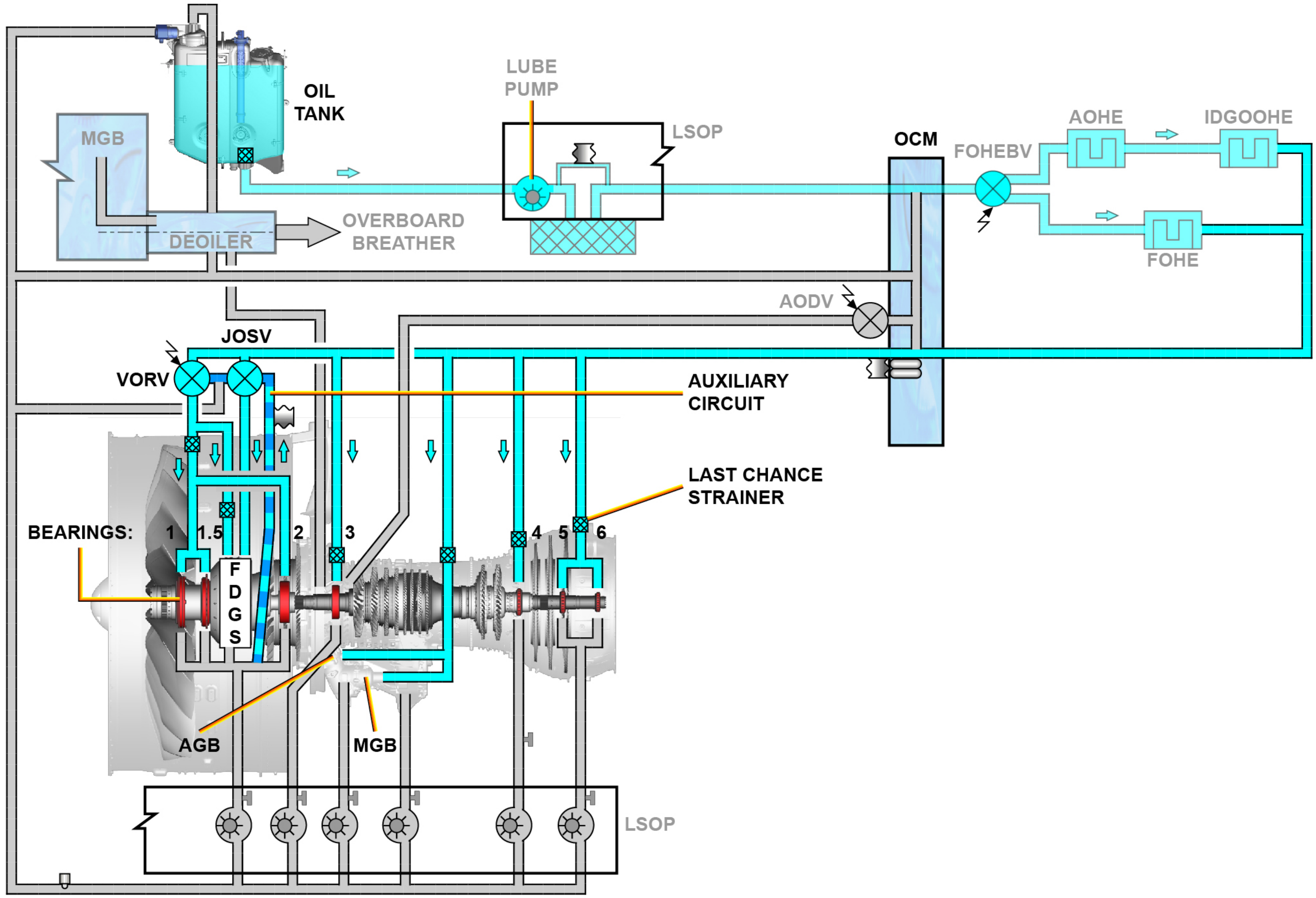
OIL SYSTEM D/O (3)

OIL SUPPLY

Oil flows from the pressurized oil tank to the lube pump in the Lubrication and Scavenge Oil Pump (LSOP).
The pressurized oil is directed to the main oil filter and to the Oil Control Module (OCM). The main part of the filtered oil flows to the Fuel/Oil Heat Exchanger Bypass Valve (FOHEBV) which modulates the oil flow between the AOHE and the FOHE. The oil flow that is directed to the AOHE also flows through the IDGOOHE.
The FOHEBV is electrically controlled and monitored by the Electronic Engine Control (EEC) according to fuel temperature.
Oil from the heat exchangers is sent via the OCM to the No. 3, 4, 5, 6 bearings and to the AGB and MGB.
Oil is also sent to the Variable Oil Reduction Valve (VORV) / Journal Oil Shuttle Valve (JOSV) which modulates the flow of oil to the No. 1, 1.5, 2 and Fan Drive Gear System (FDGS) based on engine power settings.
The VORV is electrically controlled and monitored by the EEC to bypass part of the oil flow to the front bearings at low power setting.
The JOSV is a mechanical device that keeps a continuous supply of oil to the fan drive journal bearings from the main oil supply in normal condition or from the auxiliary oil supply in windmill or zero or negative gravity conditions.
Nozzles in the main bearing compartments and gearboxes supply the oil to the different bearings, gears, seals, and accessory drive splines. Last chance strainers are provided at the entrance to the compartments to protect the oil nozzles from debris introduced to the oil system downstream of the main oil filter.
The other part of the filtered oil is sent through the Active Oil Damper Valve (AODV) to the No. 3 bearing damper for N2 vibration control.
The AODV is electrically controlled by the EEC to supply oil to the damper during starting and acceleration and shut it off at high power.


OIL TANK
LUBE PUMP
LSOP
OCM
FOHEBV
AOHE
IDGOOHE
FOHE
MGB
DEOILER
OVERBOARD BREATHER
AODV
JOSV
VORV
LSOP

OIL SUPPLY


OIL TANK
LUBE PUMP
LSOP
OCM
FOHEBV
AOHE
IDGOOHE
FOHE
MGB
DEOILER
OVERBOARD BREATHER
AODV
JOSV
VORV
AUXILIARY CIRCUIT
LAST CHANCE STRAINER
BEARINGS:
1
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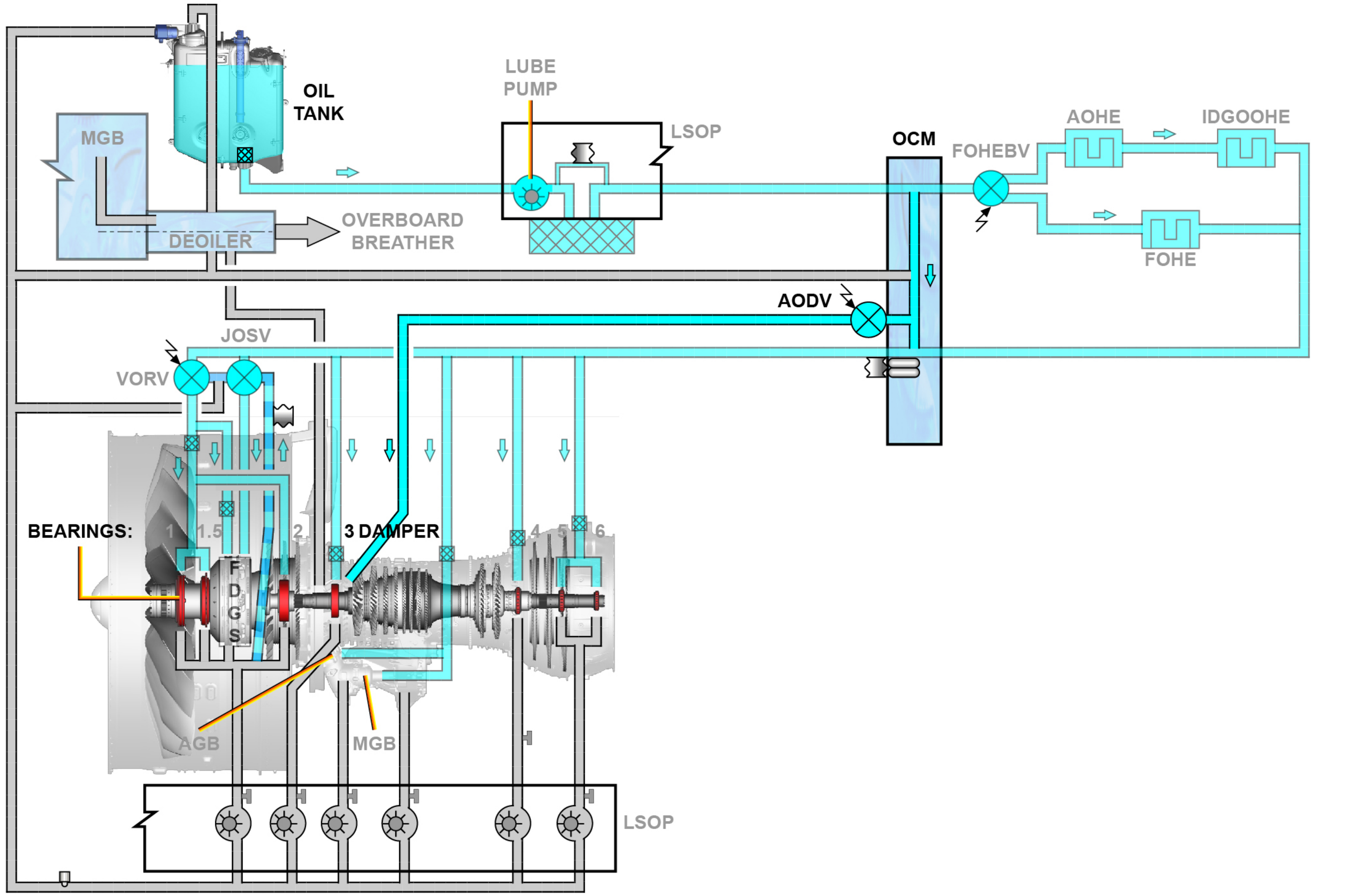
MGB
LSOP

OIL SUPPLY



OIL SUPPLY

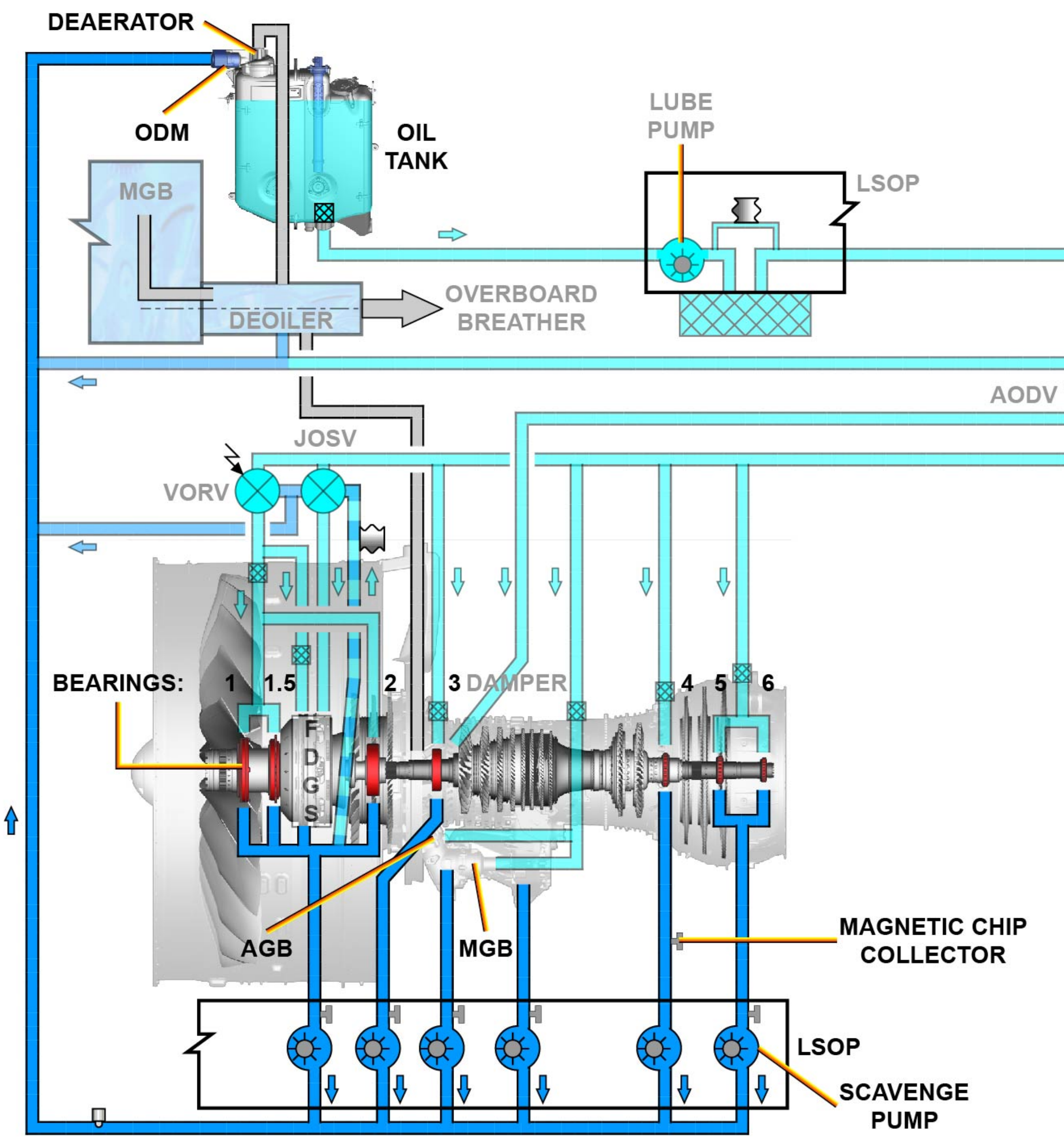
UJ515241 - U08T0MEP - UM79D1PW1100G05

OIL SYSTEM D/O (3)

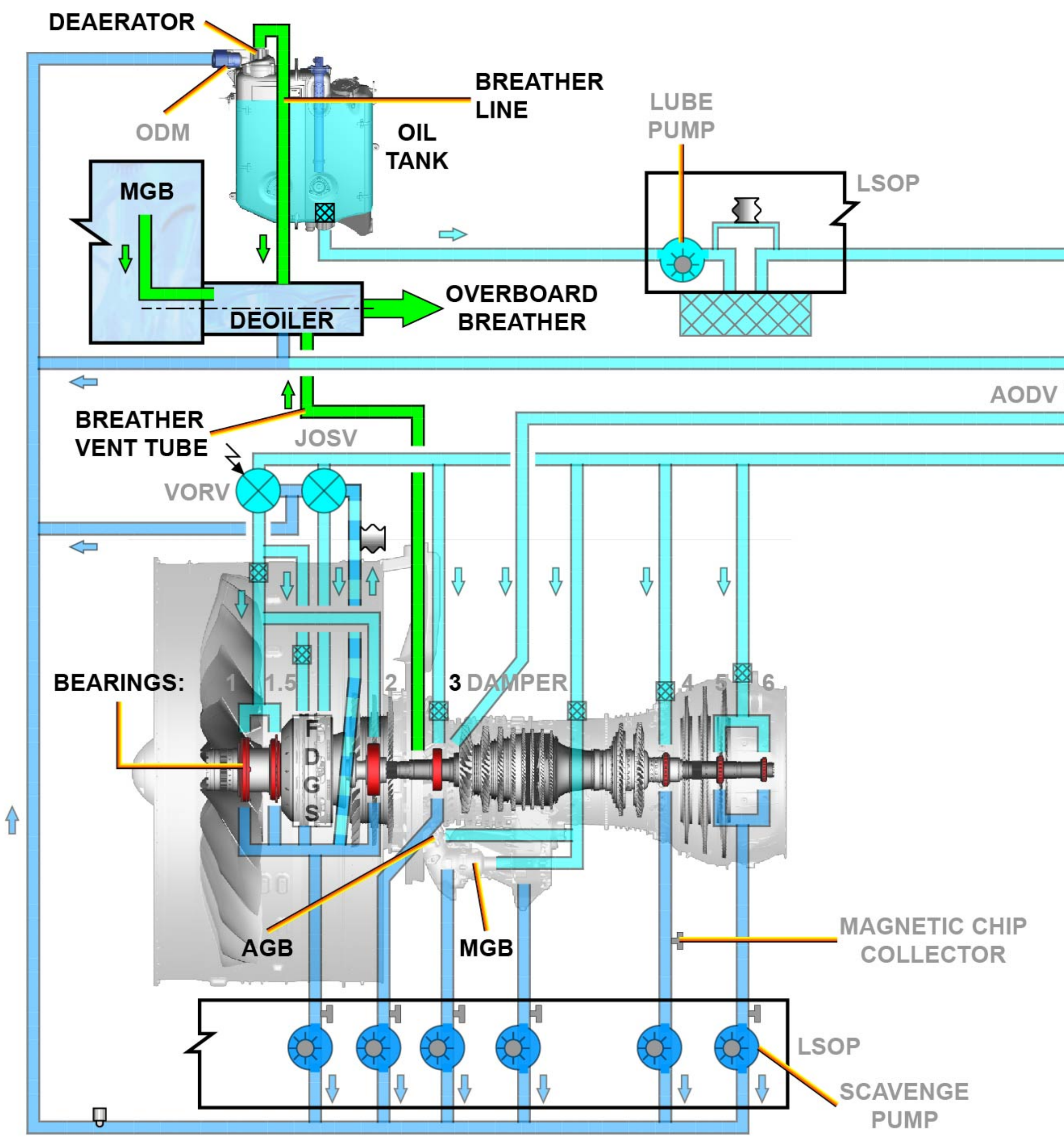
OIL SCAVENGE AND VENTING

The engine oil scavenge system is used to return the hot lubrication oil to the tank through the LSOP.
The LSOP has six scavenge pumps that are used to pull scavenge oil from the:
- No. 1, 1.5, 2 bearing and FDGS,
- No. 3 bearing compartment,
- No. 4 bearing compartment,
- No. 5 and 6 bearing compartment,
- MGB,
- AGB.

Six magnetic chip collectors, installed upstream of the scavenge pumps, catch ferrous metal particles.
The scavenge pumps send the scavenge oil to the oil tank through the Oil Debris Monitor (ODM) and the deaerator.
The ODM senses the size and quantity of ferrous and non-ferrous particles in the scavenge oil system and the corresponding signal is processed by the Prognostic Health Monitoring Unit (PHMU).
The engine oil breather system is used to remove sealing air from the bearing compartments, separate the air from the oil, and vent it overboard.
In the tank, the deaerator is a static component that separates the air that is mixed with the scavenged oil. Part of the air is used to pressurize the tank and the excess is sent to the centrifugal deoiler.
The deoiler is mechanically connected and driven by the MGB and receives the air/oil mist internally from the MGB, from the tank by the breather line and from the No. 3 bearing compartment by a dedicated breather vent tube.



OIL SCAVENGE AND VENTING



OIL SCAVENGE AND VENTING

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OIL SYSTEM D/O (3)

OIL MONITORING AND INDICATING

The oil monitoring and indicating system comprises:
- Oil Level (OL) indicating,
- Oil Debris Monitoring (ODM),
- Main Oil Temperature (MOT) indicating,
- Main Oil Pressure (MOP) indicating,
- Low Oil Pressure (LOP) indicating,
- Oil Filter Differential Pressure (OFDP),
- Auxiliary Oil Pressure (AOP) indicating.

OIL LEVEL INDICATING

The oil level sensor is installed on the top of the oil tank.
It is of the magnetic float and reed switch type. The signal proportional to the oil level is sent to the EEC channel B.

OIL DEBRIS MONITORING

The Oil Debris Monitoring (ODM) sensor is installed between the main oil scavenge line and the deaerator in the oil tank.
It detects any type of pollution that crossed its electromagnetic field.
The signal corresponding to the ferrous and non-ferrous debris is processed by the PHMU. The PHMU calculates the number of particles in a given time period and sends it to the EEC channel A.
The EEC compares the data to predefined values and generates a maintenance signal.

MAIN OIL TEMPERATURE INDICATING

The dual oil temperature sensor is installed on the OCM.
It measures the scavenge oil temperature in the scavenge oil line and sends the signals to both EEC channels.

MAIN OIL PRESSURE INDICATING

The dual main oil pressure sensor is installed on OCM.
It measures the pressure on the oil supply line and sends the signals to both EEC channels.

LOW OIL PRESSURE INDICATING

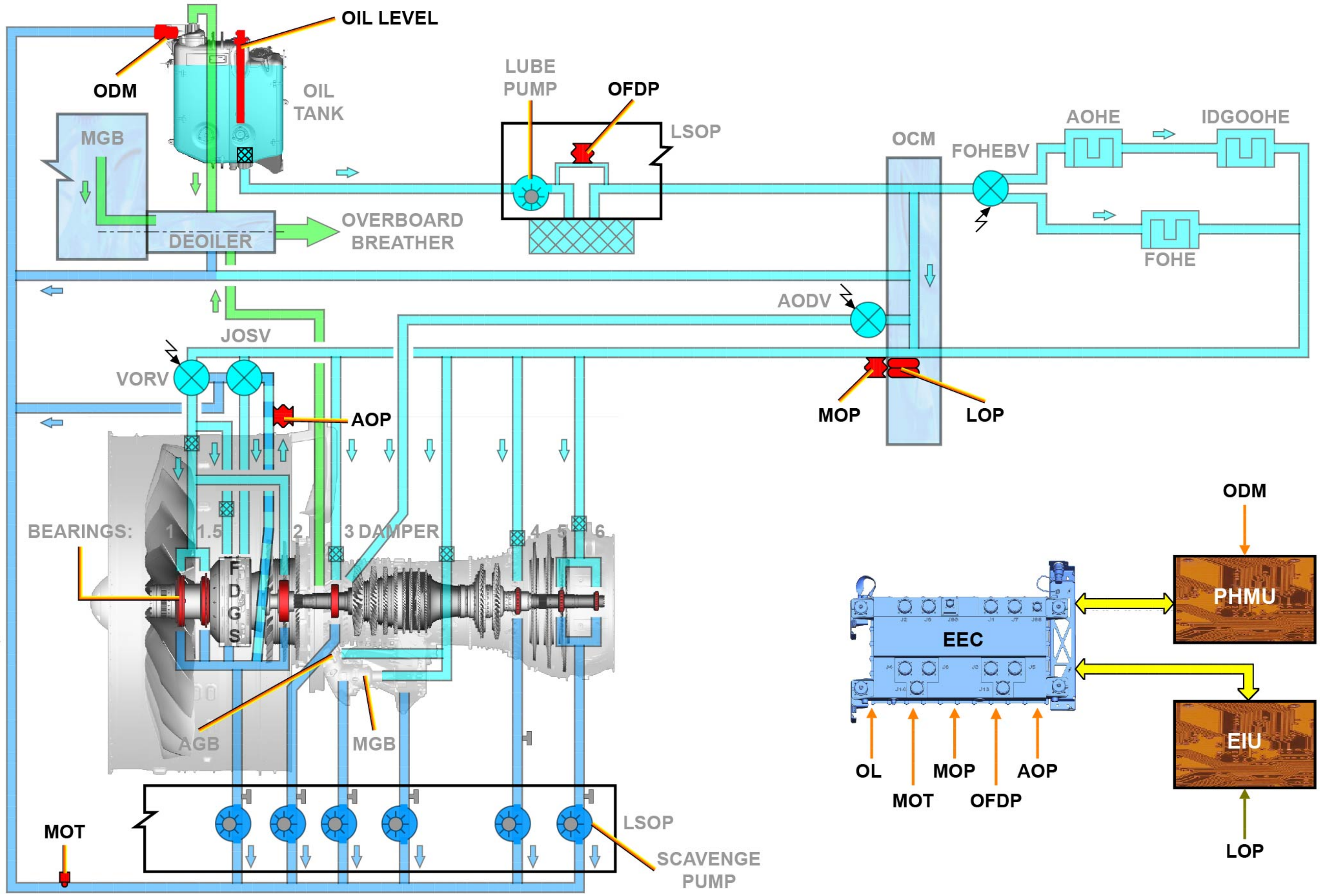
The low oil pressure switch is installed on OCM.
It detects low oil pressure condition on the oil supply line and sends the signals to the Engine Interface Unit (EIU).

OIL FILTER DIFFERENTIAL PRESSURE

The oil filter differential pressure sensor is installed on the OCM, adjacent to the oil filter.
The differential pressure signal is sent to both EEC channels.
When the differential pressure across the filter is more than the specified limit, a maintenance signal is generated.
When the differential pressure across the primary oil filter element is too much, the filter bypass valve will open.
The pressurized oil then will go directly to the secondary filter and an oil filter bypass signal is also generated.

AUXILIARY OIL PRESSURE INDICATING

The dual auxiliary oil pressure sensor is installed on the VORV / JOSV assembly.
It measures the pressure of the auxiliary oil supply for the journal bearings of the FDGS and sends it to both EEC channels to detect failures in the JOSV or the oil auxiliary pump.



OIL MONITORING AND INDICATING - OIL LEVEL INDICATING ... AUXILIARY OIL PRESSURE INDICATING

UJ515241 - U08T0MEP - UM79D1PW1100G05

ENGINE SYSTEM OPERATION, CONTROL & INDICATING (3)

FADEC POWERING / ENGINE CONTROLS

ENG 1 HP FUEL VALVE FAULT

ENG 1 EIU FAULT

ENG 1 OIL FILTER CLOG

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OPENING & CLOSING OF ENGINE COWL DOORS (2)

OPENING OF THE ENGINE FAN COWL DOORS

Before working on the engine, safety precautions have to be taken.

WARNING: KEEP PERSONNEL AND EQUIPMENT CLEAR OF THE FAN COWL DOORS WHEN THE HOLD OPEN RODS ARE NOT LOCKED. THE COWL DOORS CAN CLOSE QUICKLY AND INJURY TO PERSONS OR DAMAGE TO EQUIPMENT CAN OCCUR.
DO NOT ATTEMPT TO OPEN THE FAN COWL DOORS IF THE WIND SPEED IS HIGHER THAN 96 KM/H (60 MPH).
BE CAREFUL IF YOU OPEN A FAN COWL DOOR WHEN THE WIND SPEED IS 40 KM/H (25 MPH) OR MORE. IF THE WIND MOVES THE FAN COWL DOOR, INJURY TO PERSONS AND/OR DAMAGE TO THE ENGINE CAN OCCUR.

In the cockpit, make sure that the ENG MODE rotary selector is in the NORM position.
Make sure that the ENG MASTER 1(2) lever was in the OFF position not less than five minutes before you do this procedure.
Put WARNING NOTICE(S) in position to tell persons not to operate the ENG MODE rotary selector and the ENG MASTER 1(2) lever.
On the ENG section of maintenance panel 50VU, make sure that the ON legend of the FADEC GND PWR 1(2) pushbutton switch is off.
Put WARNING NOTICE(S) in position to tell persons not to energize FADEC 1(2).
Make sure that the slats are retracted.
Put WARNING NOTICE(S) in the cockpit to tell persons not to move the slat control lever.

CAUTION: DO NOT OPEN THE FAN COWL IF THE WING LEADING EDGE SLATS ARE EXTENDED. DAMAGE TO THE FAN COWL, WING LEADING EDGE SLATS AND WING CAN OCCUR.

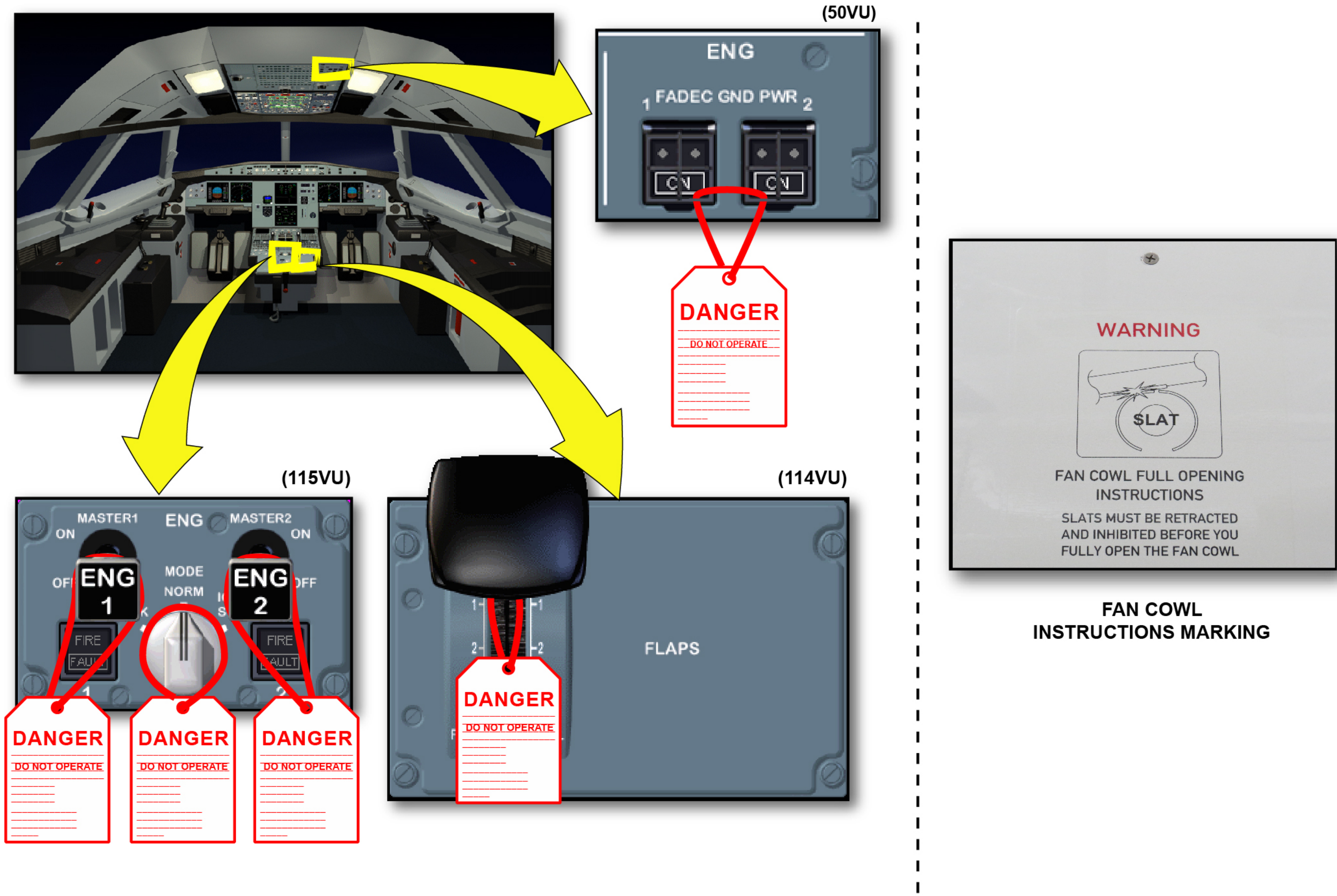
On the engine, unlock and open the three latches:
Push the fan cowl door latch triggers to release the AFT latch, CENTER latch and the FWD latch on the bottom of the left fan cowl door.
Pull down in sequence each handle (first the AFT then the CENTER then the FWD) to open the three latches.
Move the latches away from the three latch keepers.

NOTE: The push-open devices on the fan cowl doors will push the doors apart after you release the last latch.

Push the fan cowl door latch trigger to release the side latch on the right fan cowl door (3 o'clock position).
Pull the handle to release the right fan cowl from the inlet cowl.
Manually lift and hold the left fan cowl door at the lower edge.
Lift the left fan cowl door until the telescoping Hold Open Rod (HOR) correctly engages and locks into position (green band visible).
Make sure that the telescoping HOR is at the correct length.
Remove, lock and attach the fixed HOR to the bracket on the engine.
Slowly lower the left fan cowl door until the fixed HOR and the telescoping HOR hold the weight of the door.

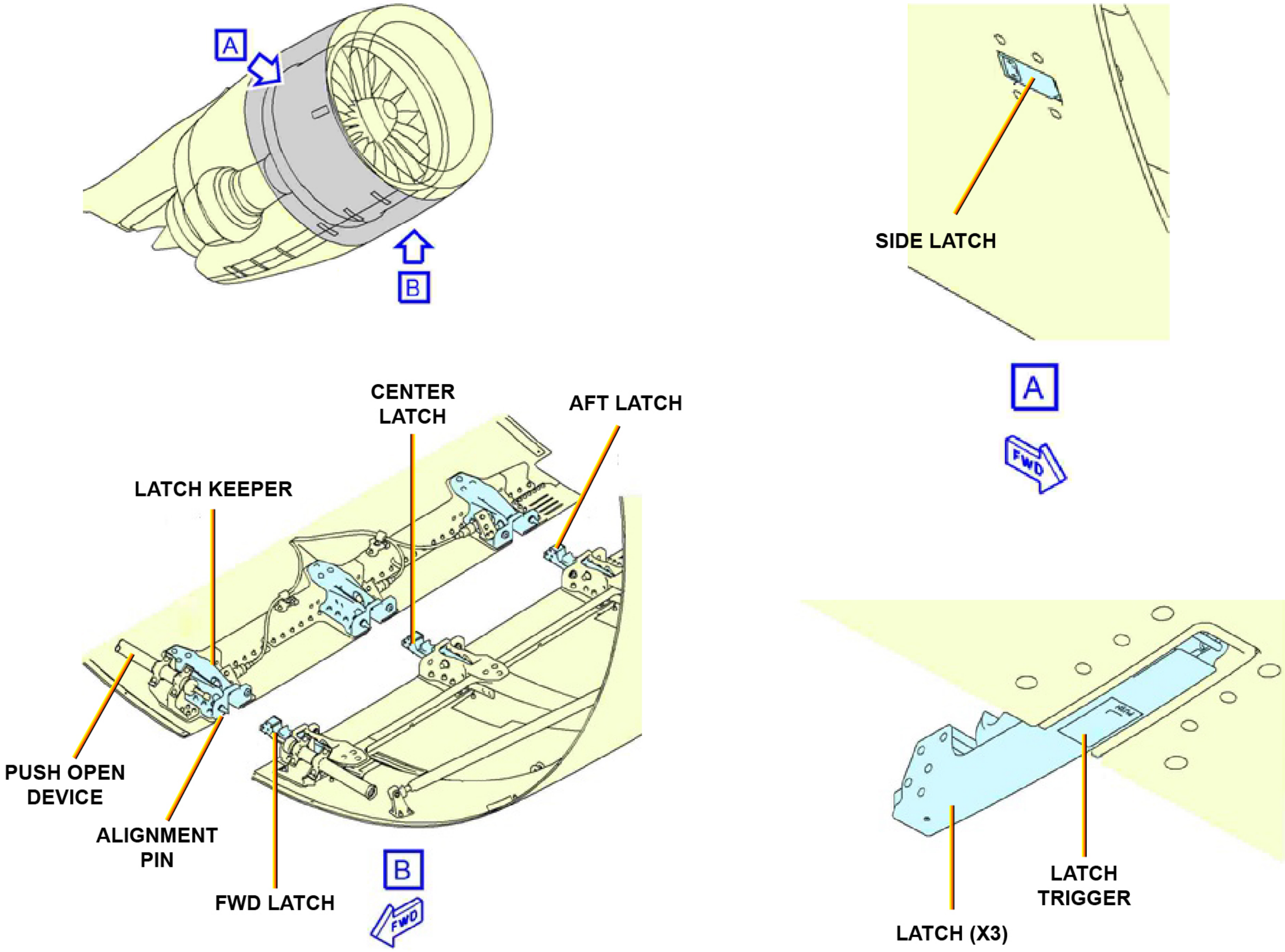
CAUTION: BE CAREFUL IF YOU LIFT THE FAN COWL DOOR MORE THAN 52 DEGREES FROM THE VERTICAL. DAMAGE TO THE FAN COWL DOOR OR PYLON CAN OCCUR.

If required, repeat this procedure for the other fan cowl door.
Make an entry in the logbook.

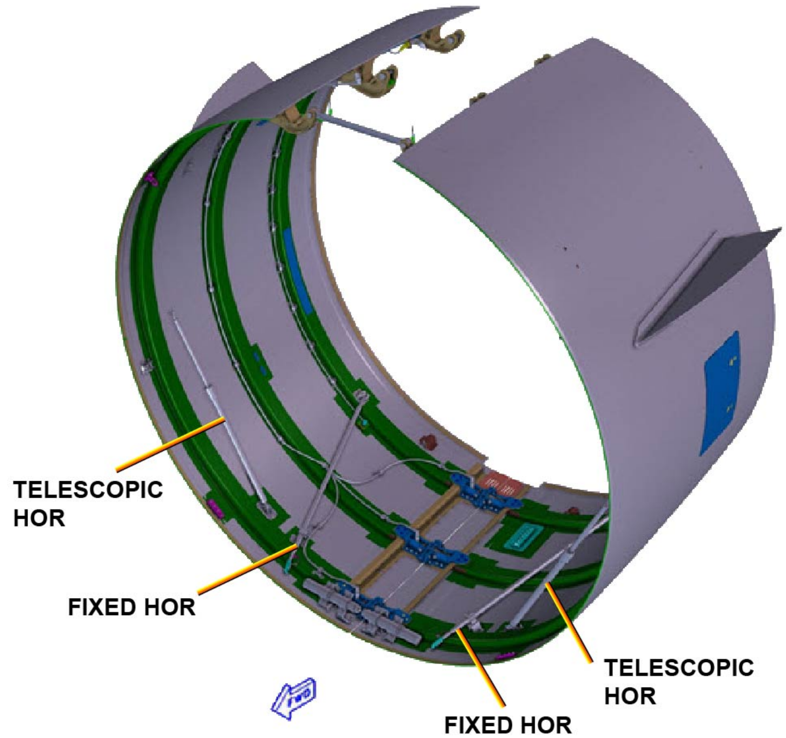


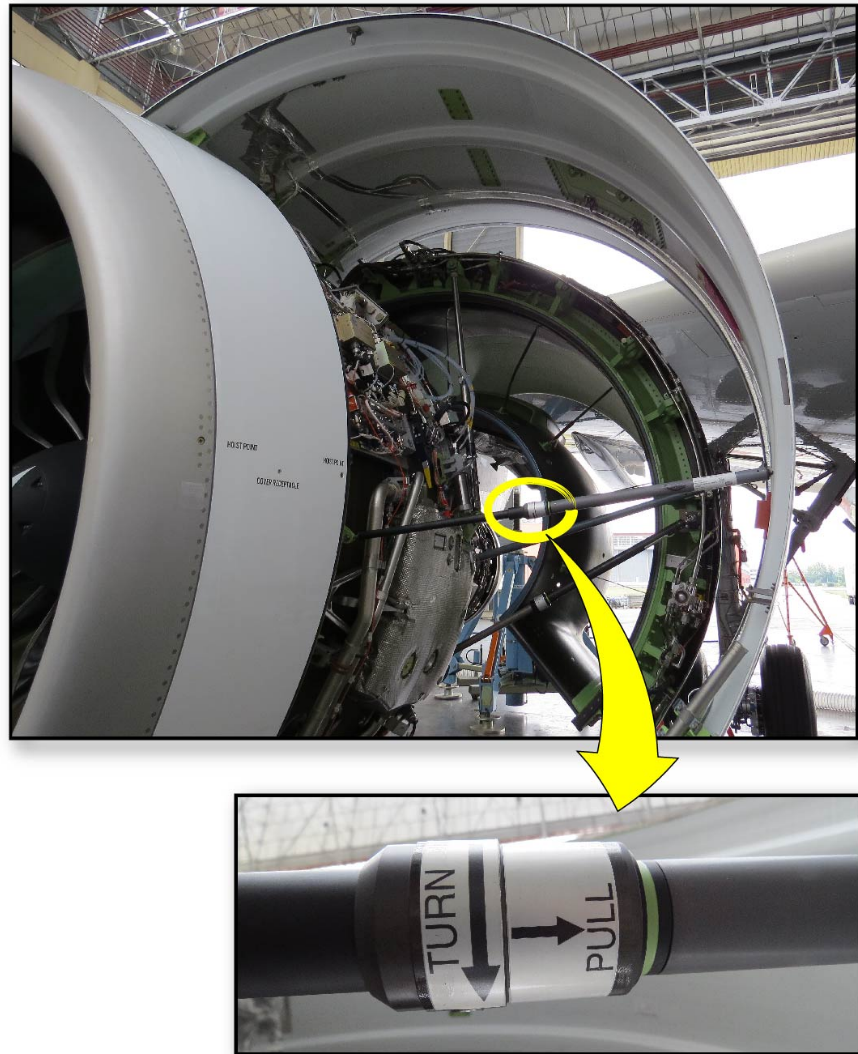
OPENING OF THE ENGINE FAN COWL DOORS

UJ515241 - U08T0MEP - UM70Y2PW1100G05



OPENING OF THE ENGINE FAN COWL DOORS





LOCKED HOLD OPEN ROD (HOR)

OPENING OF THE ENGINE FAN COWL DOORS

UJ515241 - U08T0MEP - UM70Y2PW1100G05

OPENING & CLOSING OF ENGINE COWL DOORS (2)

OPENING OF THE ENGINE THRUST REVERSER COWL DOORS

Do the deactivation of the thrust reverser system for maintenance as per the AMM.

WARNING: DO NOT KEEP OPEN A THRUST REVERSER DOOR WHEN THE WIND SPEED IS 83.5 KM/H (51.6 MPH) OR MORE. IF THE WIND MOVES THE THRUST REVERSER DOOR, INJURY TO PERSONS AND/OR DAMAGE TO EQUIPMENT CAN OCCUR.
BE CAREFUL IF YOU OPEN OR CLOSE A THRUST REVERSER DOOR WHEN THE WIND SPEED IS 37 KM/H (23 MPH) OR MORE. IF THE WIND MOVES THE THRUST REVERSER DOOR, INJURY TO PERSONS AND/OR DAMAGE TO EQUIPMENT CAN OCCUR.

NOTE: Do not open the left and right thrust-reverser cowl-doors at the same time. Thrust-reverser cowl-doors must be opened one after the other.

If necessary, engage the closure assist assembly.

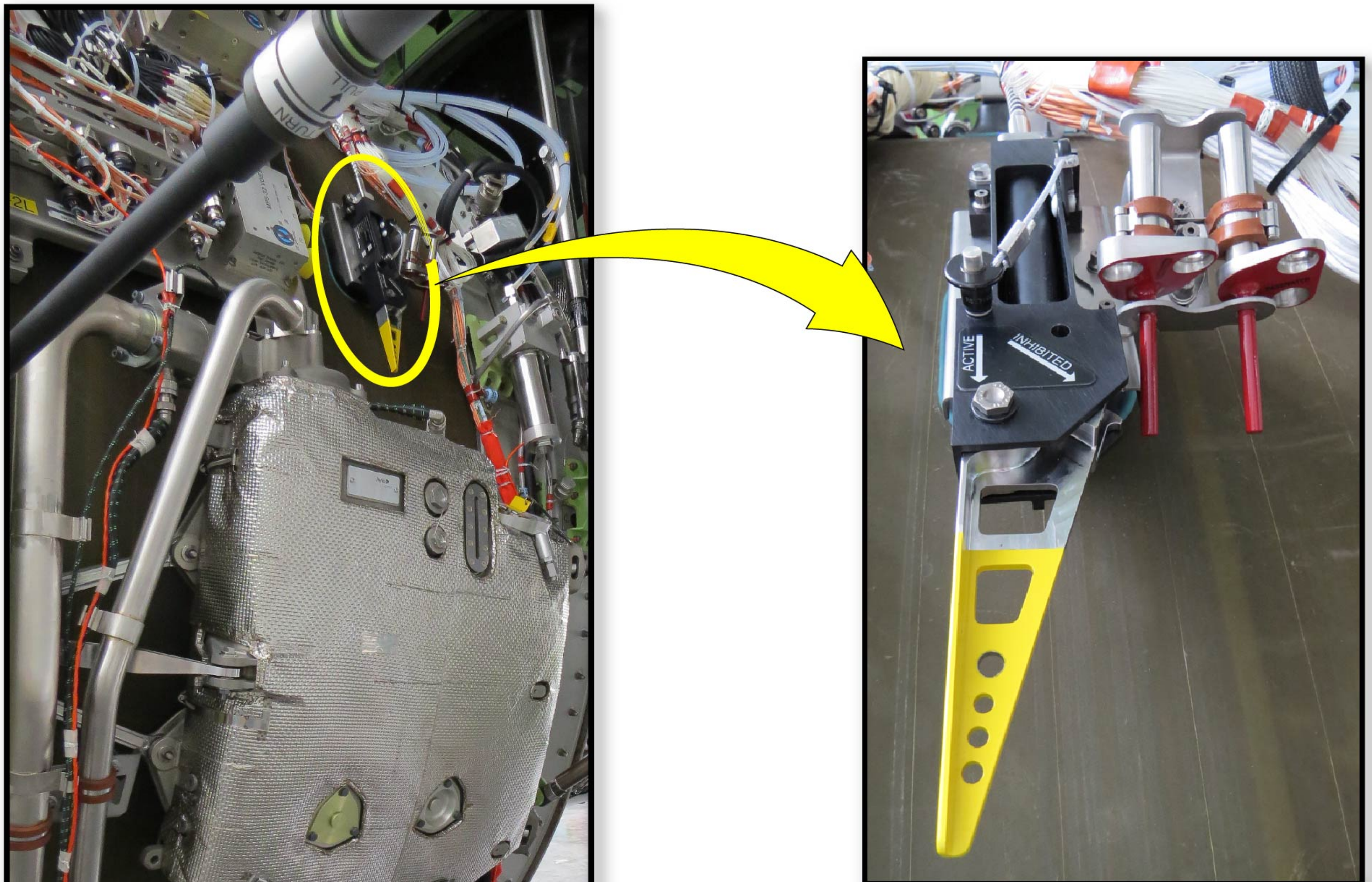
NOTE: The closure assist assembly only helps to open or close the L1A and L1B latches. It is not necessary to use the closure assist assembly if you can open and close these latches without it.

On the Thrust Reverser Cowl, push the latch trigger to release and open the latches in sequence: L5, L4, L3, Bifurcation Latching System (BLS), L2, L1A and L1B.
Connect the hand pump flexible hose to the quick disconnect fitting of the Door Opening System (DOS) actuator and operate it until the DOS actuator opens the left thrust reverser door to 45 degrees.
Manually release the pressure from the DOS actuator.

NOTE: The DOS actuator will retract until the compressive lock in the actuator engages.

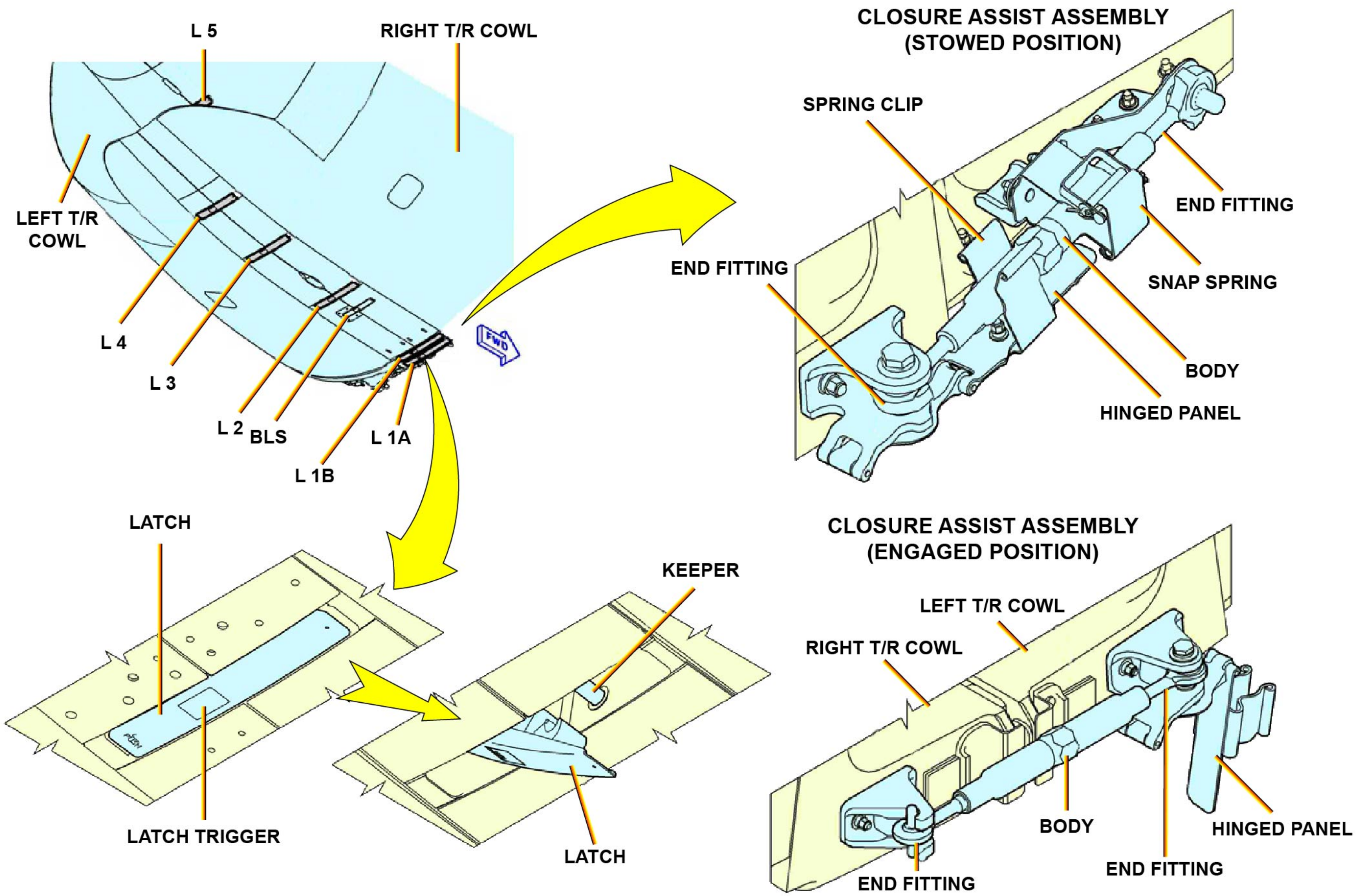
WARNING: DO NOT MOVE BETWEEN THE ENGINE AND THE OPEN THRUST REVERSER DOOR UNTIL THE COMPRESSIVE LOCK IN THE DOS ACTUATOR IS ENGAGED. THE THRUST REVERSER DOOR IS HEAVY. IT WILL CLOSE QUICKLY IF THE DOS ACTUATOR FAILS. THIS CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.

Release and extend the hold open rod.
Adjust it as necessary and attach it to the HOR support bracket on the fan case. Make sure it is locked (green band visible).
If necessary, repeat the sequence to open the right Thrust Reverser Cowl.



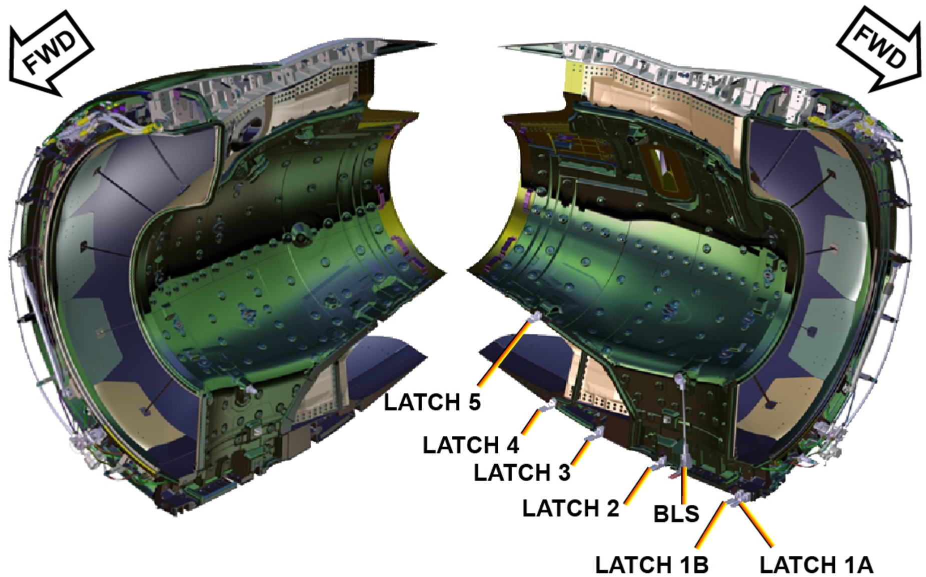
THRUST REVERSER INHIBITION LEVER

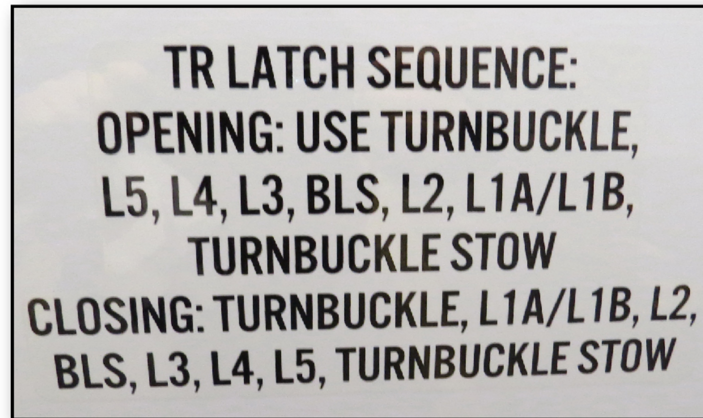
OPENING OF THE ENGINE THRUST REVERSER COWL DOORS



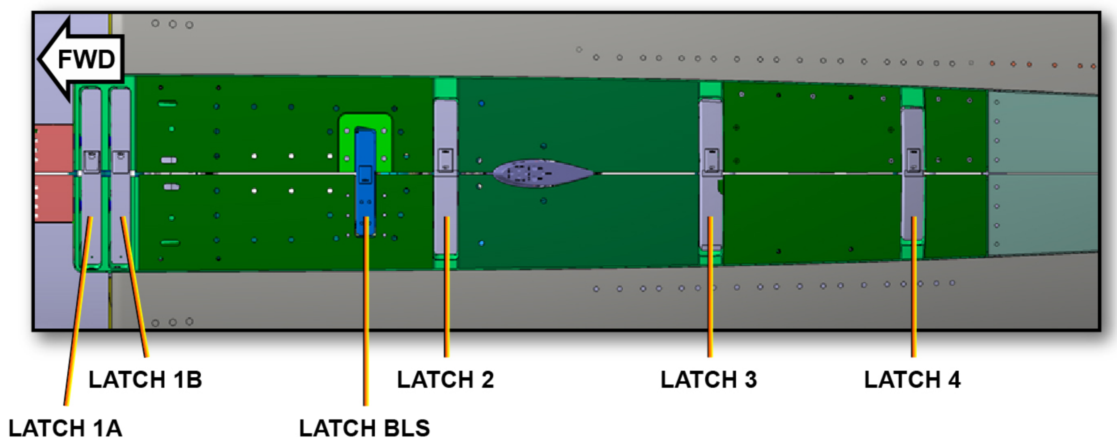
OPENING OF THE ENGINE THRUST REVERSER COWL DOORS

UJ515241 - U08T0MEP - UM70Y2PW1100G05



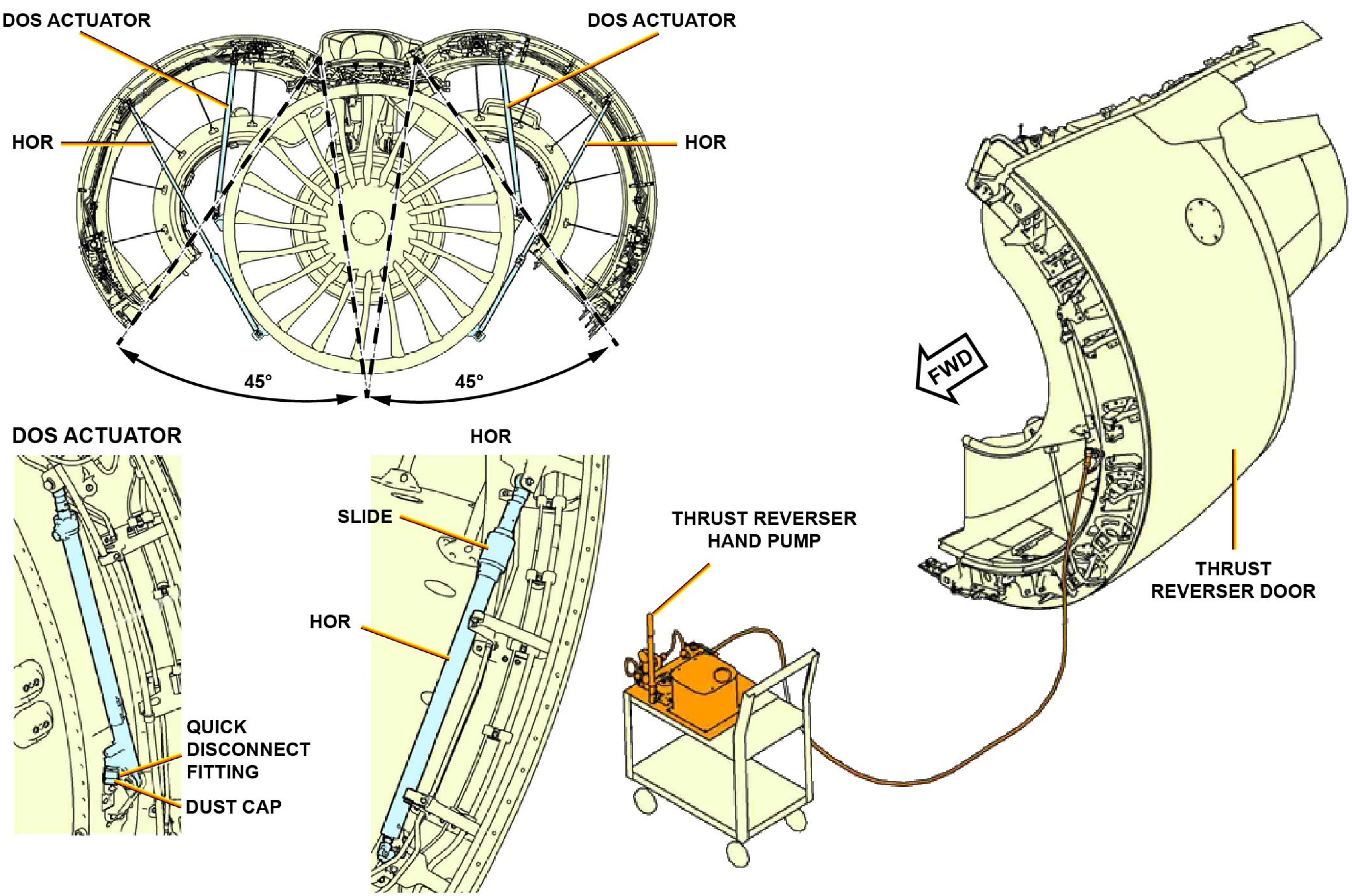

TR LATCH SEQUENCE:
OPENING: USE TURNBUCKLE,
L5, L4, L3, BLS, L2, L1A/L1B,
TURNBUCKLE STOW
CLOSING: TURNBUCKLE, L1A/L1B, L2,
BLS, L3, L4, L5, TURNBUCKLE STOW

THRUST REVERSER LATCHES



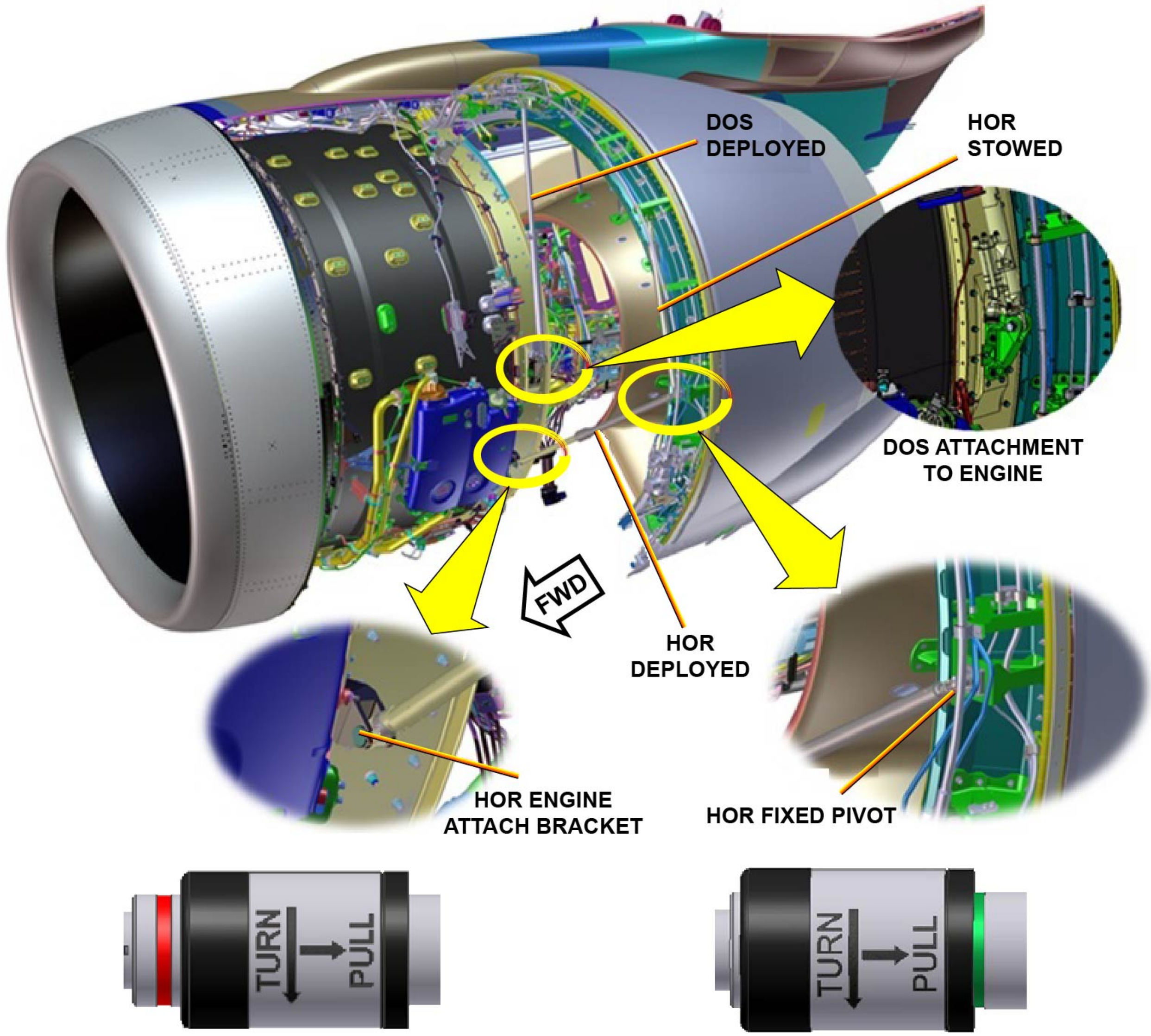
OPENING OF THE ENGINE THRUST REVERSER COWL DOORS

UJ515241 - U08T0MEP - UM70Y2PW1100G05



OPENING OF THE ENGINE THRUST REVERSER COWL DOORS

UJ515241 - U08T0MEP - UM70Y2PW1100G05



OPENING OF THE ENGINE THRUST REVERSER COWL DOORS

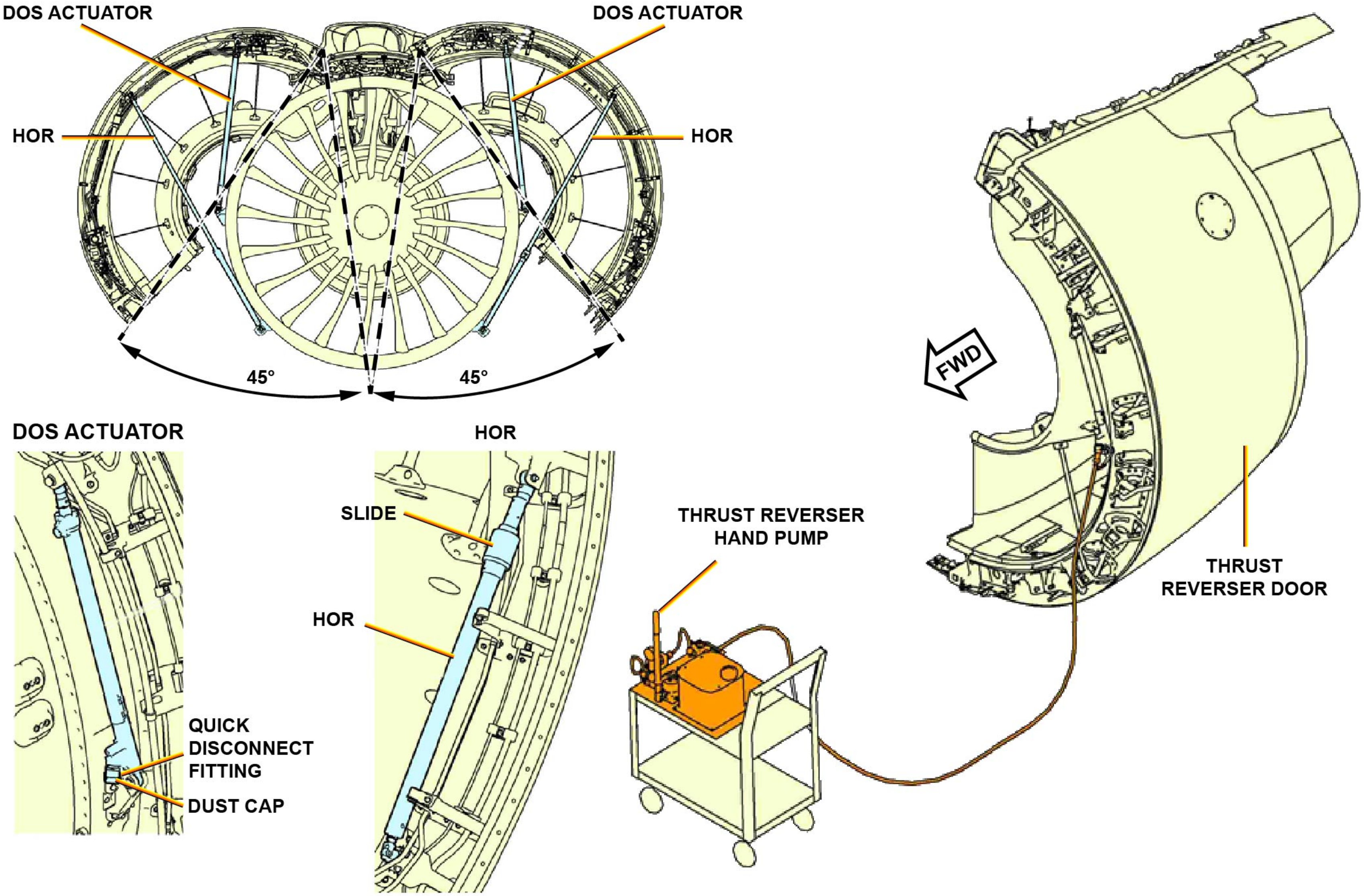
OPENING & CLOSING OF ENGINE COWL DOORS (2)

CLOSING OF THE ENGINE THRUST REVERSER COWL DOORS

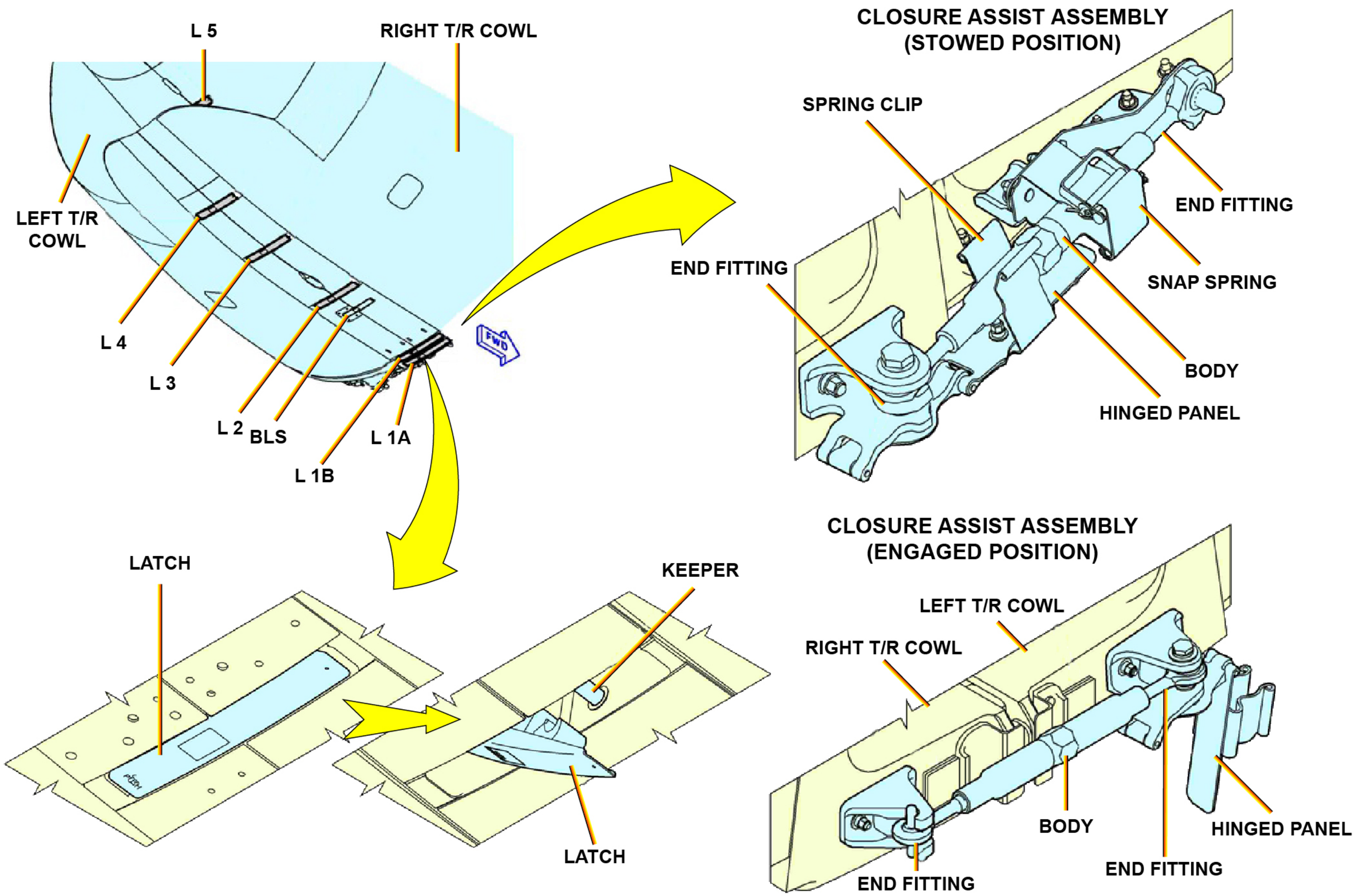
Pay attention of the warnings and cautions mentioned for Fan and Thrust Reverser cowls opening.
Make sure that you did the deactivation of the thrust reverser system for maintenance.

NOTE: Do not close the thrust-reverser cowl-doors at the same time. Thrust-reverser cowl-doors must be closed one after the other.
Connect the hand pump flexible hose to the quick disconnect fitting of the DOS actuator and operate it until the DOS actuator opens the left thrust reverser door to be able to release the HOR from its support bracket on the fan case.
Adjust the length of the HOR as necessary and attach it to the HOR stow bracket on the left thrust reverser door.
Operate the hand pump until the DOS actuator is fully extended, the compressive lock in the actuator disengages, and the pressure relief valve in the actuator is open. Manually release the pressure from the DOS actuator to close the pressure relief valve.

NOTE: The DOS actuator will retract at a constant speed until the thrust reverser door closes.
Disconnect the hand pump flexible hose.
Repeat the same sequence to close the right thrust reverser door.
If necessary, engage the closure assist assembly:
- Move it out of the stow bracket.
- Adjust the length until the end fitting can be attached to the closure assist hook on the right thrust reverser door.
- Engage it in the closure assist hook.
- Turn the body of the closure assist assembly with a WRENCH to pull the two thrust reverser doors together until you can engage the L1A and L1B latches at the bottom of the doors.
- Stow the closure assist assembly in its storage position.
When you engage the L1A and L1B latches, if the force you measure is not between 17.8 daN (40 lbf) and 22.2 daN (50 lbf), adjust the thrust reverser doors.
Close the remaining thrust reverser door latches in the sequence that follows: L1A, L1B, 2, BLS, 3, 4 and 5.
If the force you measure is not between 17.8 daN (40 lbf) and 22.2 daN (50 lbf), adjust the thrust reverser doors.
Make sure that the work area is clean and clear of tool(s) and other items.
Reactivate the T/R.



CLOSING OF THE ENGINE THRUST REVERSER COWL DOORS



CLOSING OF THE ENGINE THRUST REVERSER COWL DOORS

UJ515241 - U08T0MEP - UM70Y2PW1100G05

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OPENING & CLOSING OF ENGINE COWL DOORS (2)

CLOSING OF THE ENGINE FAN COWL DOORS

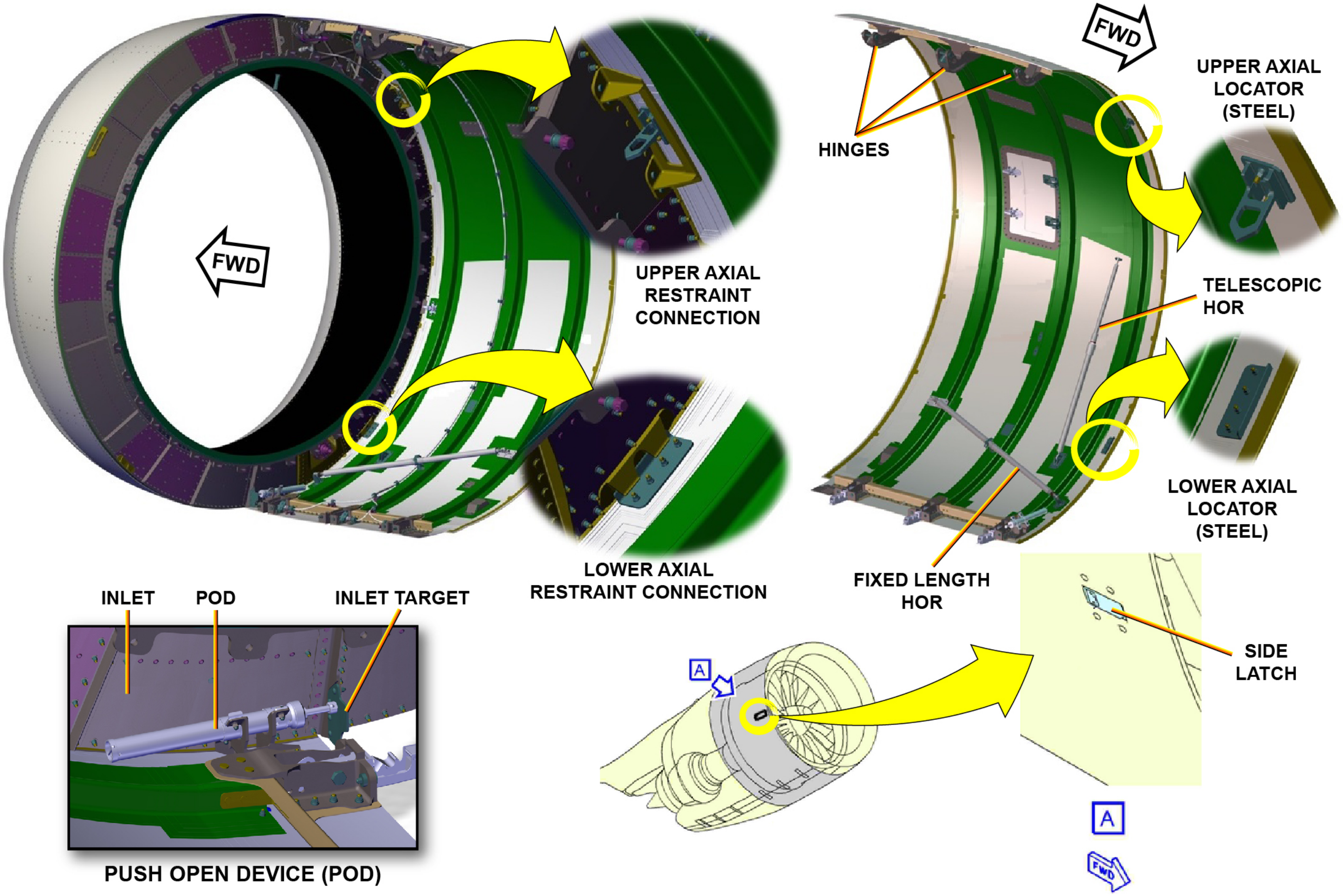
Manually lift and hold the left fan cowl door at the lower edge so that the weight is not on the HOR and telescoping HOR.
Disconnect the fixed HOR from the engine bracket and attach it to the stow bracket on the left fan cowl door.
Manually lift the left fan cowl door until the telescoping HOR extends sufficiently so that you can turn the release collar.
Turn the collar and pull it up to unlock the telescoping HOR.

NOTE: When the telescoping HOR is unlocked, you will no longer see a green band adjacent to the release collar. You will see a red band adjacent to the release collar.

Slowly lower the left fan cowl door until it is on the bottom. Perform the same steps to lower the right fan cowl door.
Push the right fan cowl door until it is against the inlet cowl.
Make sure that the axial locators on the right fan cowl door engage the locator clips on the inlet cowl.
Close the side latch on the right fan cowl door until the latch is flush with the door surface and locked into position.
Make sure that the latch engages with the inlet cowl.
Push the left fan cowl door against the right fan cowl door.
Make sure that the alignment pins go into the holes adjacent to the FWD, CENTER and AFT latches.
Make sure that the axial locators on the left fan cowl door engage the locator clips on the inlet cowl.

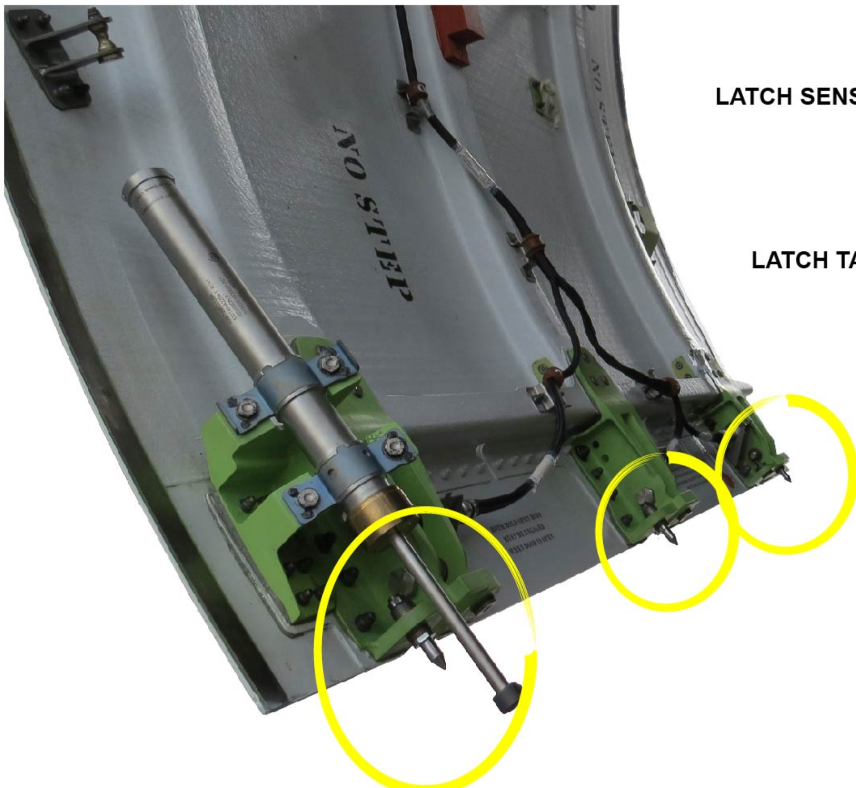
NOTE: The push-open devices on the fan cowl doors will push the doors as you close them.

Once the side latch on the right fan cowl door is latched and flush with the cowl, engage the hook on the FWD latch with the related latch keeper.
Close the FWD latch until it is flush with the door surface and locked into position.
Engage the hook on the CENTER latch with the related latch keeper.
Close the CENTER latch until it is flush with the door surface and locked into position.
Engage the hook on the AFT latch with the related latch keeper.
Close the AFT latch until it is flush with the door surface and locked into position.
Make sure that the force to close each latch is between 8.9 daN (20 lbf) and 13.3 daN (30 lbf). If not, adjust the fan cowl latches.
Make sure that the distance between the left and right fan cowl doors is between 1.5 mm (0.060 in.) and 4.5 mm (0.180 in.). If not adjust the fan cowl latches.
The proximity sensors installed on each latch detect improper latching and trigger an ECAM indication.



UJ515241 - U08T0MEP - UM70Y2PW1100G05

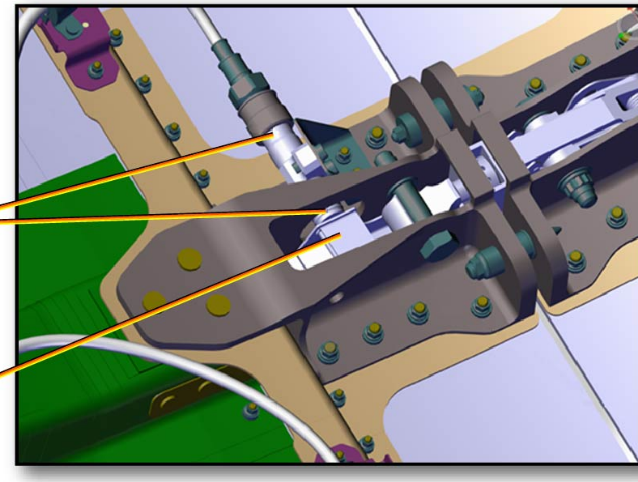
CLOSING OF THE ENGINE FAN COWL DOORS



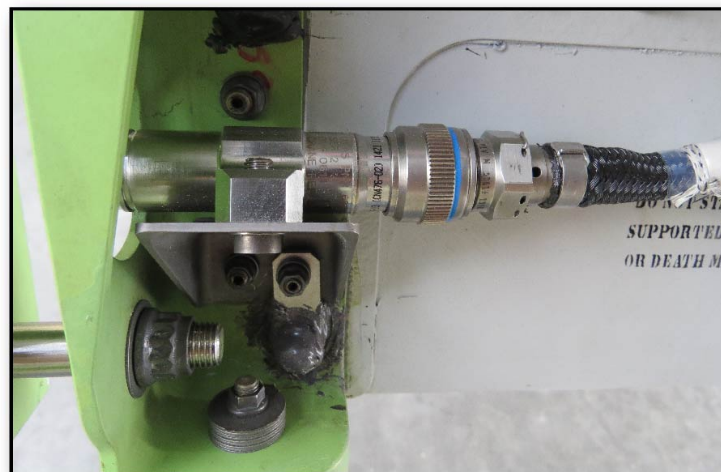
ALIGNMENT PINS

LATCH SENSOR

LATCH TARGET



PROXIMITY SENSOR



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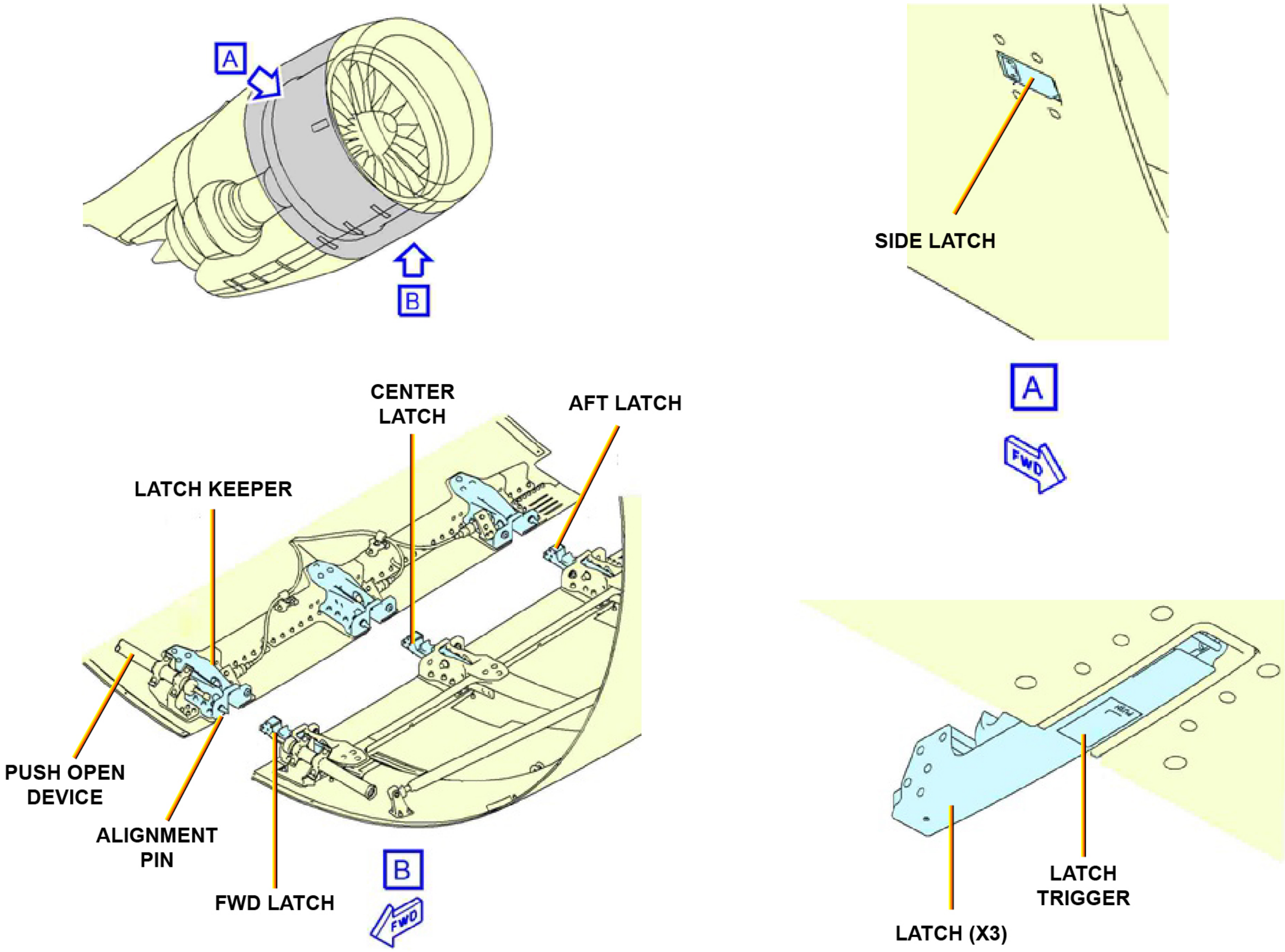
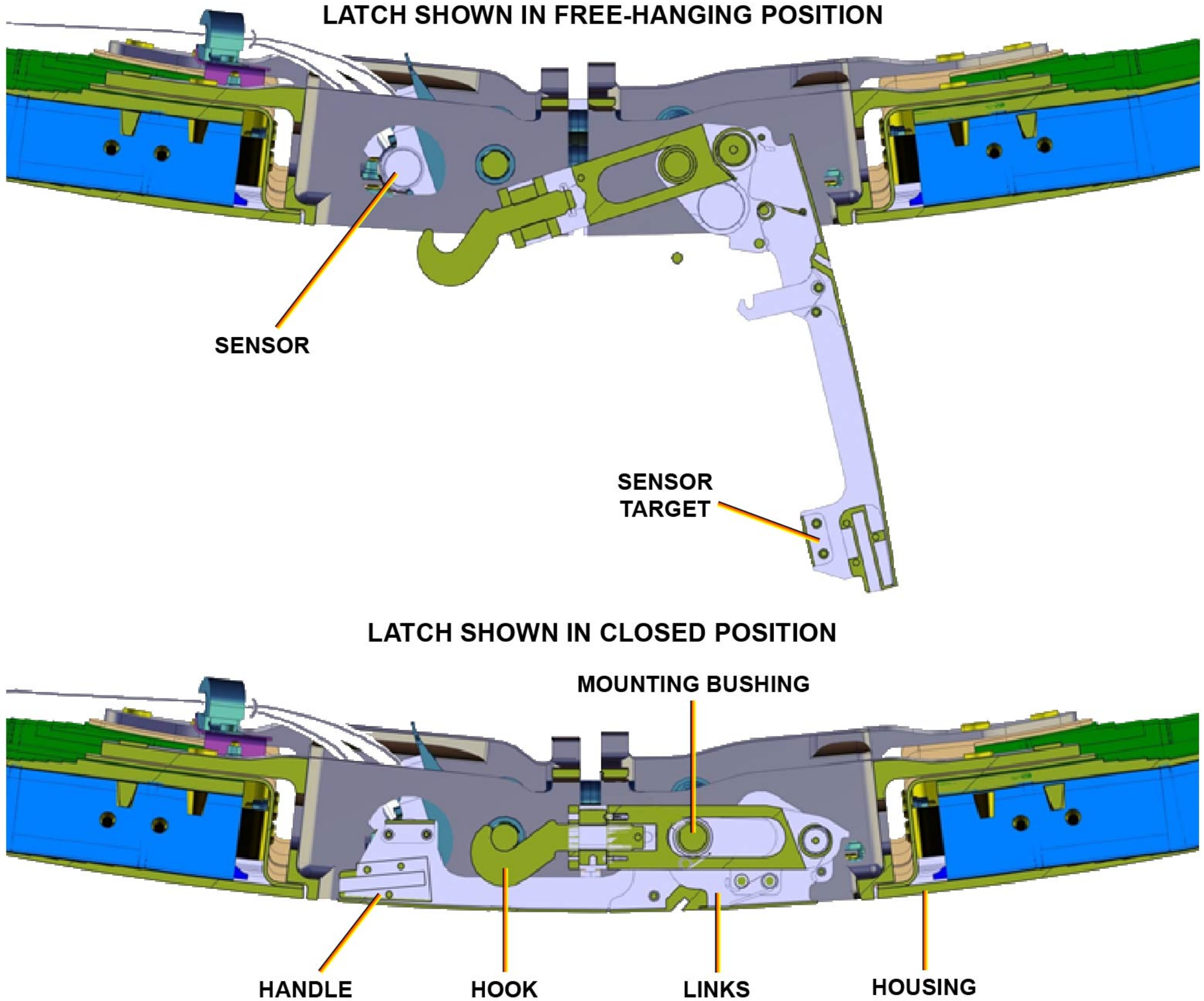
CLOSING OF THE ENGINE FAN COWL DOORS



CLOSING OF THE ENGINE FAN COWL DOORS

UJ515241 - U08T0MEP - UM70Y2PW1100G05



UJ515241 - U08T0MEP - UM70Y2PW1100G05

CLOSING OF THE ENGINE FAN COWL DOORS

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THRUST REVERSER HANDLING (3)

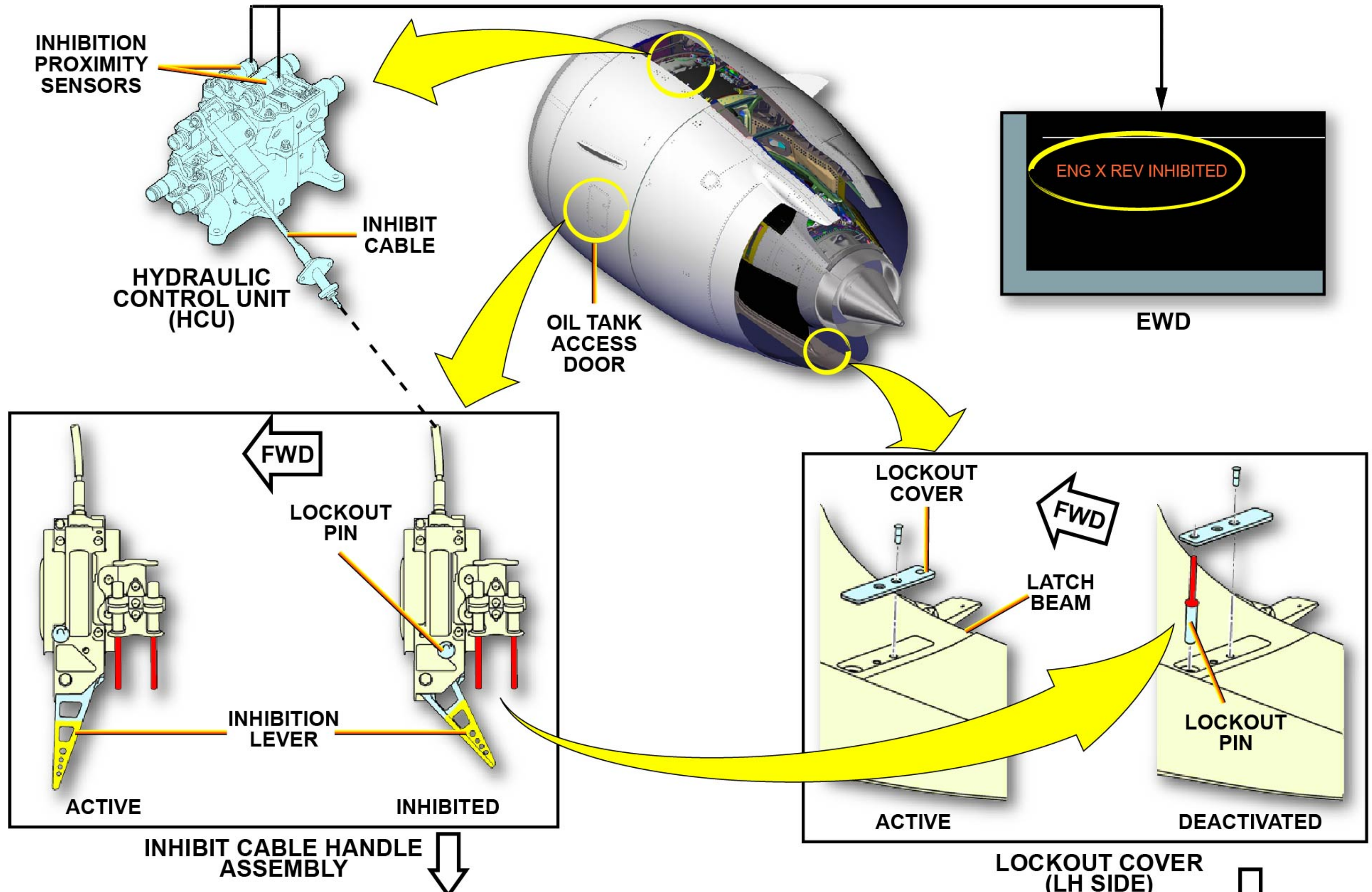
THRUST REVERSER DEACTIVATION AND LOCKOUT

Thrust reverser deactivation for ground maintenance:

- Apply the applicable safety precautions.
- Open the oil tank access-door on the left fan cowl door.
- Turn the lever on the inhibit cable handle assembly to the inhibited position and secure it with the lockout pin.

Thrust reverser deactivation for flight:

- Apply the applicable safety precautions.
- Do the Thrust Reverser deactivation for ground maintenance.
- Install the translating sleeve lockout pins in the latch beam.
- Check for the Thrust Reverser deactivation warning on the EWD.
- Make the corresponding entry in the logbook and put a warning notice in the cockpit.



	INHIBIT CABLE HANDLE ASSEMBLY		LOCKOUT COVER (LH SIDE)
DEACTIVATION FOR GROUND MAINTENANCE	X		
DEACTIVATION FOR FLIGHT	X		X (ON BOTH SIDES)

THRUST REVERSER DEACTIVATION AND LOCKOUT

UJ515241 - U08T0MEP - UM70Y3PW1100G05

THRUST REVERSER HANDLING (3)

MANUAL OPERATION OF THE THRUST REVERSER TRANSLATING SLEEVES

Manual extention of the thrust reverser translating sleeves:

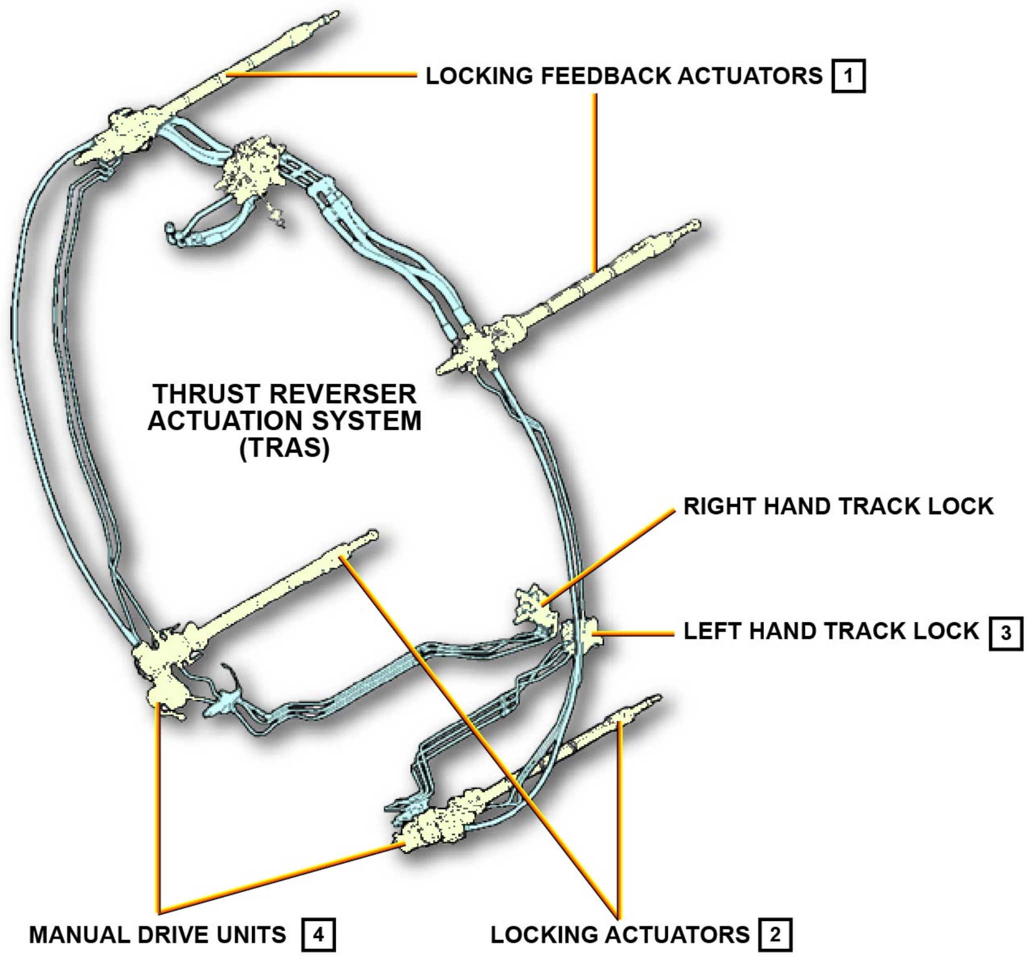
- Apply the applicable safety precautions.
- Open the fan cowl doors.
- Do the deactivation of the thrust reverser system for maintenance.
- Do the deactivation of the Thrust Reverser Actuation System (TRAS) locking feedback actuator for the applicable thrust reverser half.
- Do the deactivation of the TRAS locking actuator for the applicable thrust reverser half.
- Do the deactivation of the TRAS track lock for the applicable thrust reverser half.
- Manually extend the applicable translating sleeve by unlocking the Manual Drive Unit (MDU) and turning it with a square drive tool.

Manual retraction of the thrust reverser translating sleeves:

- Perform the steps in the opposite order.
- Do the operational test of the thrust reverser with the MCDU.

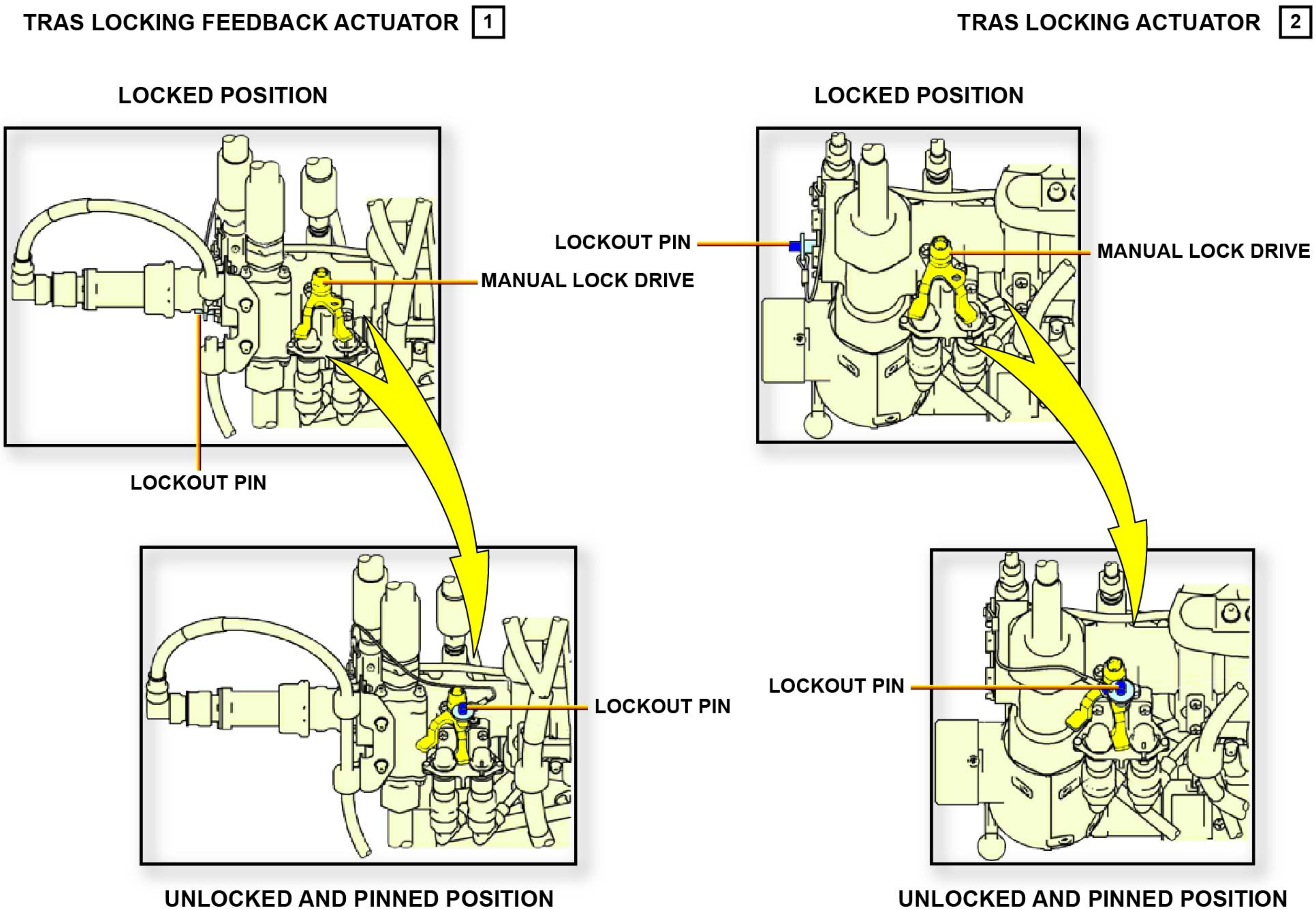
UJ515241 - U08T0MEP - UM70Y3PW1100G05

TRANSLATING SLEEVES MANUAL EXTENSION



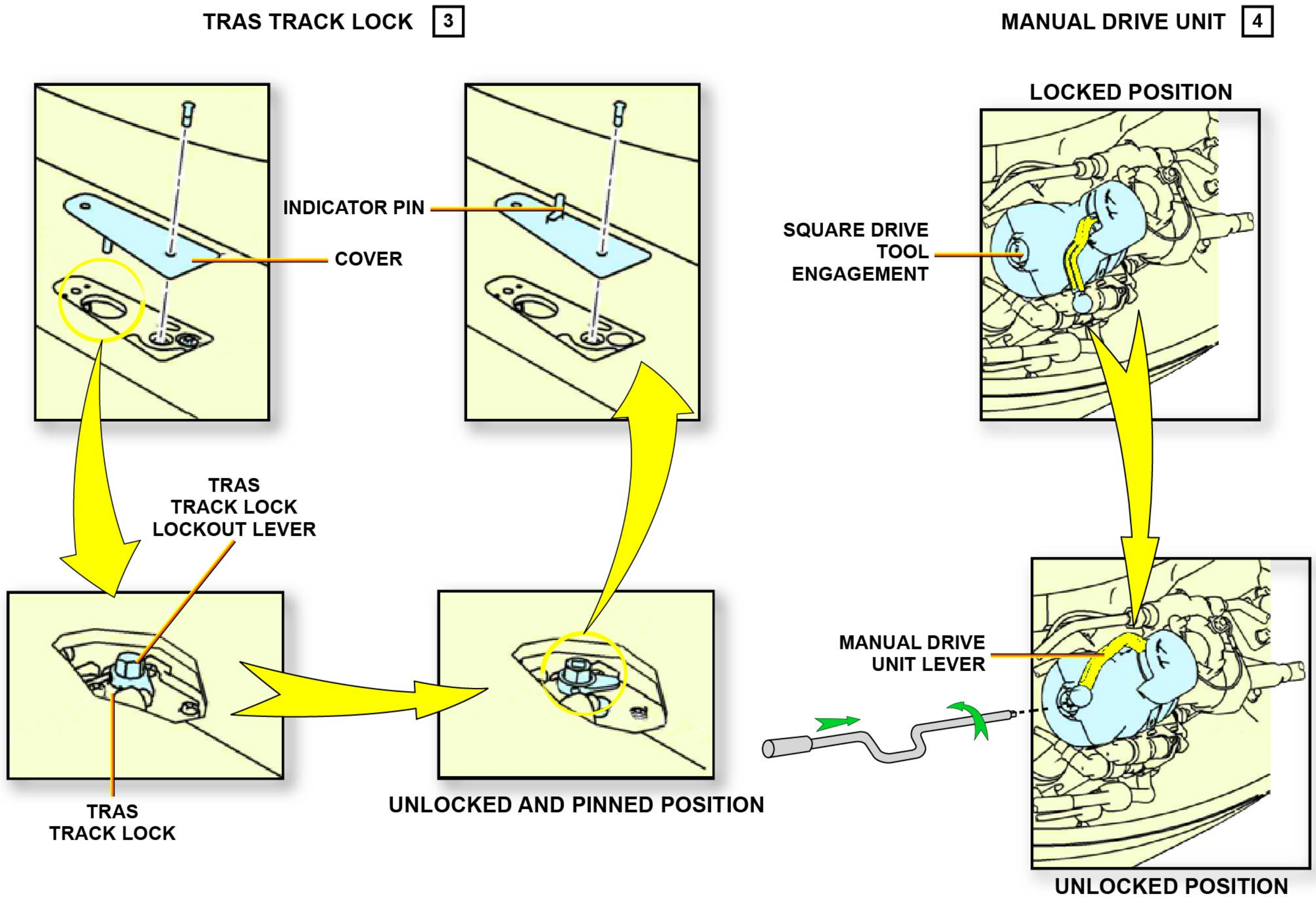
MANUAL OPERATION OF THE THRUST REVERSER TRANSLATING SLEEVES

UJ515241 - U08T0MEP - UM70Y3PW1100G05



UJ515241 - U08T0MEP - UM70Y3PW1100G05

MANUAL OPERATION OF THE THRUST REVERSER TRANSLATING SLEEVES



MANUAL OPERATION OF THE THRUST REVERSER TRANSLATING SLEEVES

UJ515241 - U08T0MEP - UM70Y3PW1100G05

POWER PLANT SYSTEM LINE MAINTENANCE (2)

ENGINE OIL SERVICING

CAUTION: Caution: The engine should be shut down for at least 5 minutes prior to oil servicing. This allows the residual pressure in the oil tank to decrease. If you open the filler cap when there is pressure in the tank the hot oil can spray out and burn you.

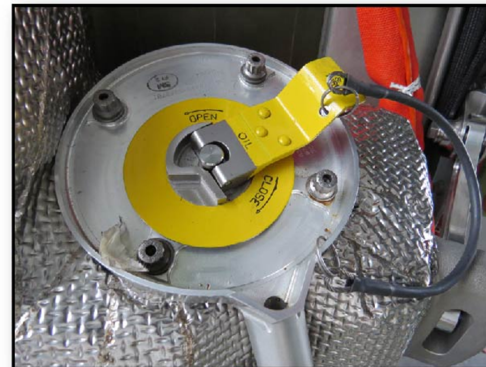
NOTE: Note: If possible, the engine oil should be checked and serviced within 15 to 120 minutes after engine shutdown.
Note: If the engine has been shutdown for more than 2 hours, dry-motor the engine until the oil pressure is stable.

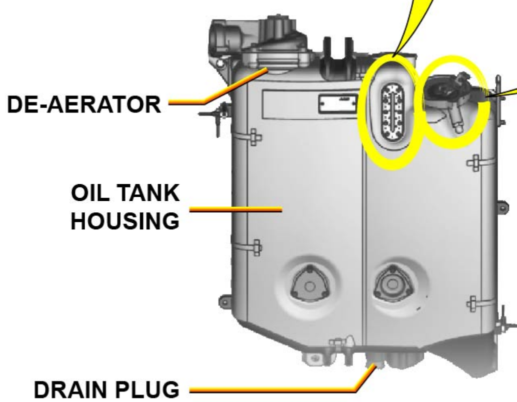
Procedure:
- open engine oil service door on left fan cowl,
- check oil level on the sight gage on the oil tank,
- raise filler cap handle to vertical (unlocked position),
- turn the oil filler cap counterclockwise and lift to remove,
- add approved oil as necessary up to the FULL mark on the sight gage,
- install oil filler cap - make sure to LOCK the cap.

PW1100G OIL TANK ACCESS DOOR

OIL LEVEL SIGHT GLASS

FILLER NECK ASSEMBLY





OIL TANK ASSEMBLY

OIL TANK CAPACITY:
39,6 quarts (37,4 liters)
FULL LEVEL:
34,9 quarts (33,1 liters)

AVOID FLUID SPILLAGE
USE APPROPRIATE STORAGE EQUIPMENT FOR CHEMICAL PRODUCTS

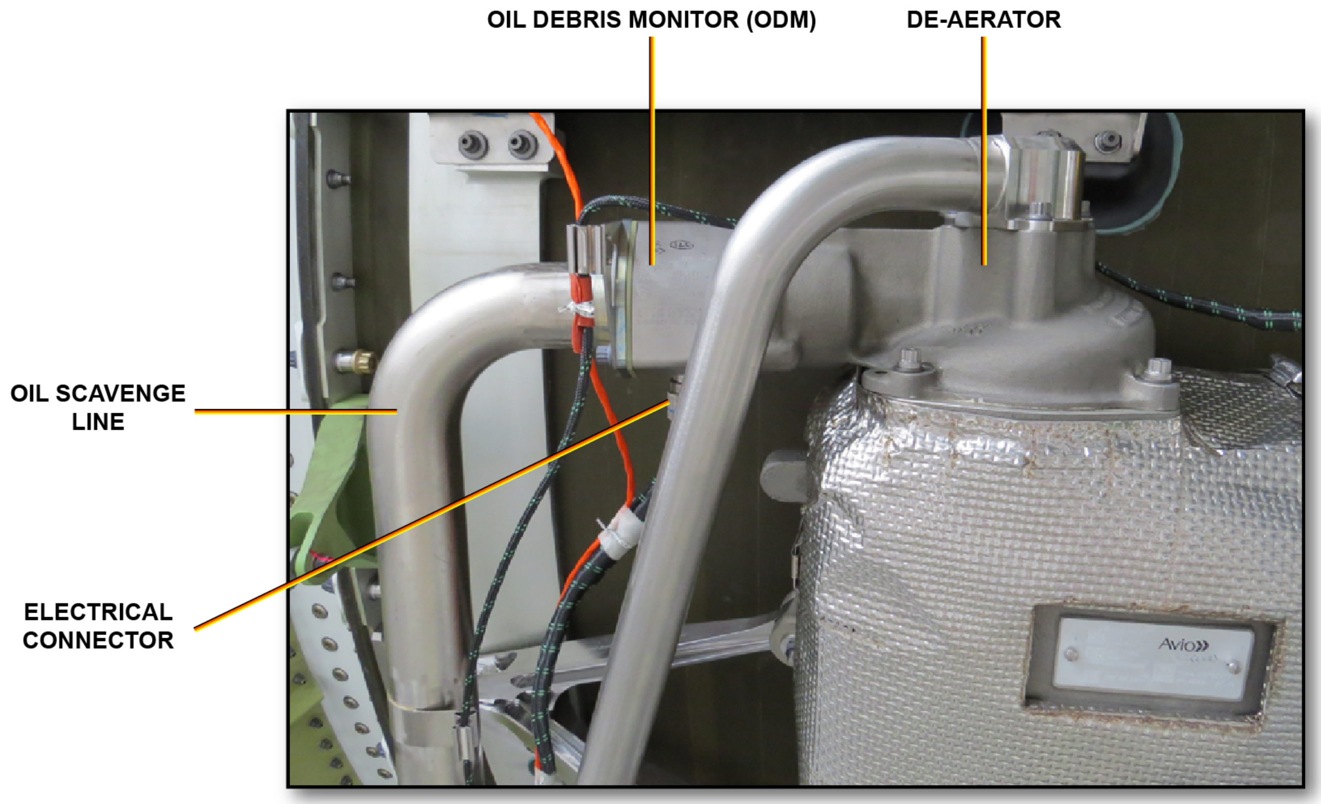
ENGINE OIL SERVICING

UJ515241 - U08T0MEP - UM70BAPW1100G05

POWER PLANT SYSTEM LINE MAINTENANCE (2)

OIL DEBRIS MONITOR (ODM)

An Oil Debris Monitor (ODM) is used to sense the size and quantity of ferrous and non-ferrous metal in the scavenge oil system. It is an in-line sensor installed between the main oil scavenge line and the de-aerator in the oil tank assembly.
When the ODM detects metallic debris in the engine lubrication system, it signals the Prognostics and Health Management Unit (PHMU) which processes to the Engine Electronic Controller (EEC); then the Engine Interface Unit (EIU) generates appropriate maintenance message.
The ODM is a Line Replaceable Unit (LRU).



OIL DEBRIS MONITOR (ODM)

UJ515241 - U08T0MEP - UM70BAPW1100G05

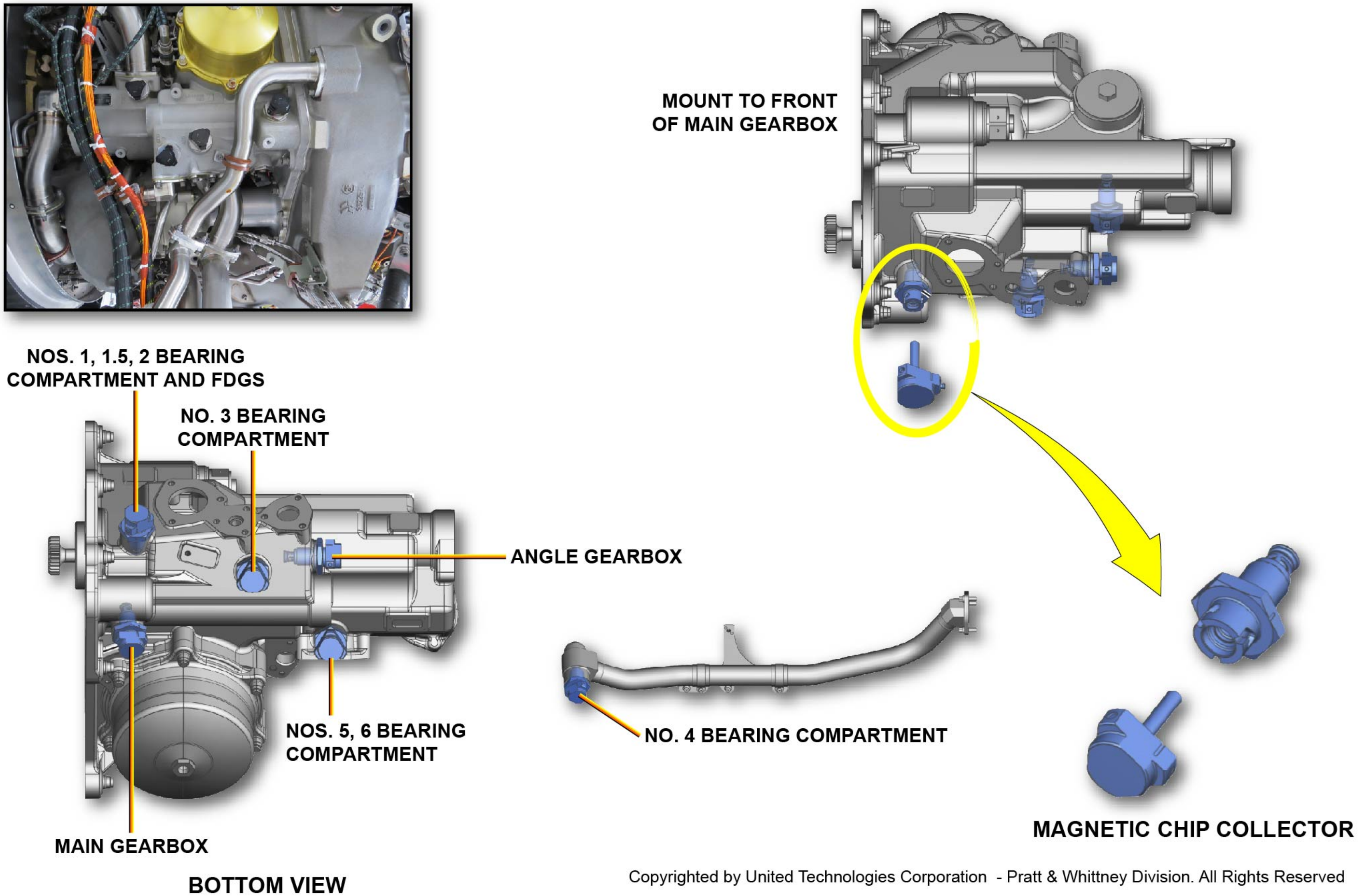
POWER PLANT SYSTEM LINE MAINTENANCE (2)

OIL DEBRIS MONITOR (ODM) (continued)

CHIP COLLECTORS

The engine oil scavenge system has six magnetic chip collectors which catch ferrous metal particles that might exist in the scavenge and supply oil:
The No. 4 bearing magnetic chip collector is located in the No. 4 bearing oil scavenge line.
The Angle Gearbox (AGB), Main Gearbox (MGB), No. 1, 1.5 and 2 Bearing and Fan Drive Gear System (FDGS), No. 3 bearing, and No. 5 and 6 bearing magnetic chip collectors are located on the lubrication and scavenge oil pump, at the 6 o'clock position.
The six chip collectors are bayonet-type plugs, they are LRUs.

LUBRICATION AND SCAVENGE OIL PUMP WITH CHIP COLLECTORS



OIL DEBRIS MONITOR (ODM) - CHIP COLLECTORS

UJ515241 - U08T0MEP - UM70BAPW1100G05

POWER PLANT SYSTEM LINE MAINTENANCE (2)

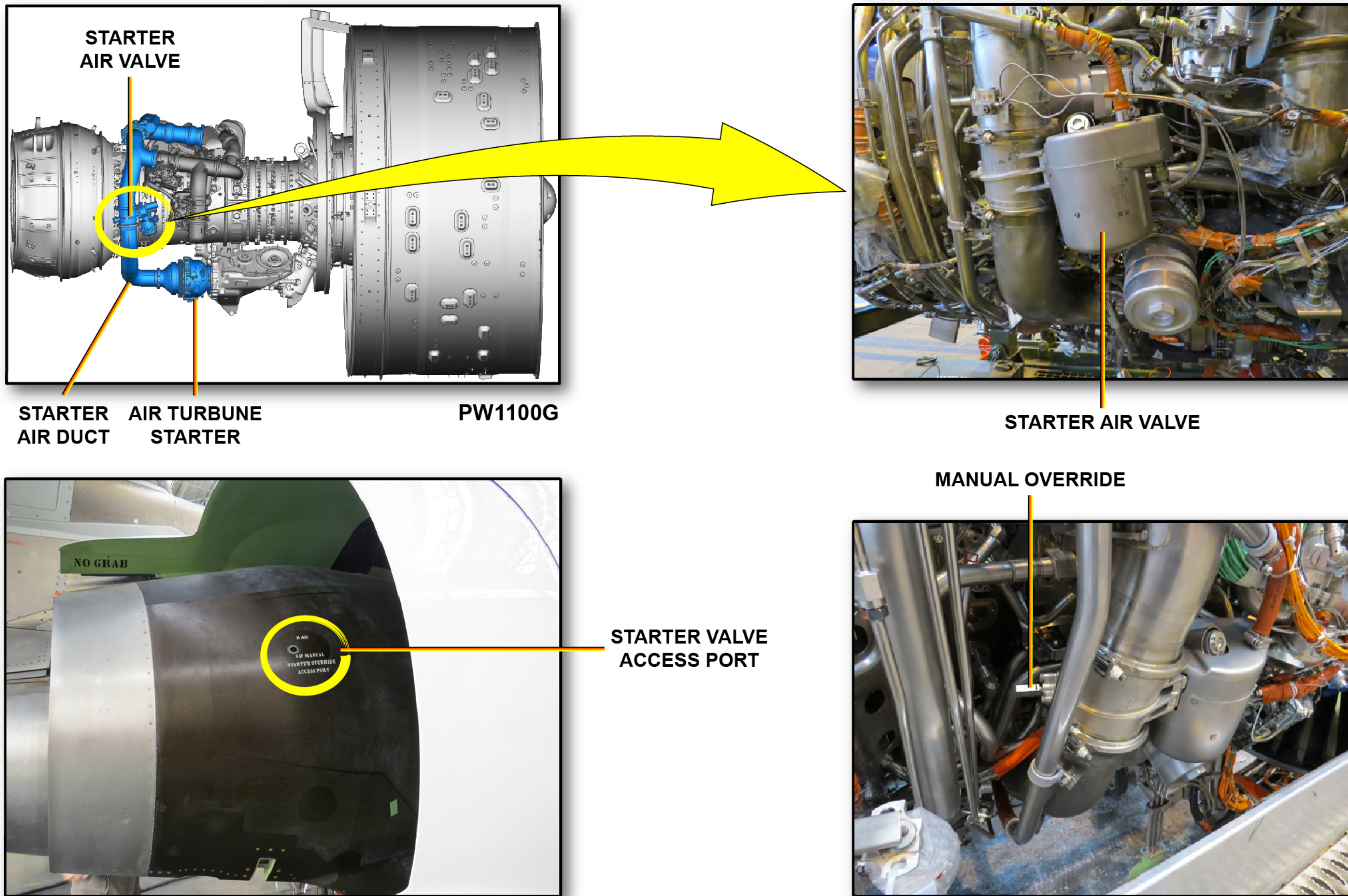
MEL / DEACTIVATION

START VALVE MANUAL OPERATION

In case of an electrical failure of the Start Air Valve (SAV), the SAV can be operated manually to start the engine.
The aircraft may be dispatched per MEL with the valve INOP closed.
- First establish the communications with the cockpit (Interphone jack on engine inlet cowl),
- then on command from the cockpit, insert a 3/8" square drive extension into the manual wrench socket located on the RH thrust reverser inner-fixed-structure at 3 O'clock.
- turn the valve shaft, this opens the butterfly valve.

WARNING: STAY AWAY FROM THE DANGER AREAS AT THE FRONT AND THE SIDES OF THE ENGINE DURING OPERATION. THE SUCTION IS SUFFICIENT AT THE AIR INTAKE COWL TO PULL A PERSON INTO (IN PART OR FULLY) THE ENGINE. THIS CAN KILL A PERSON OR CAUSE A BAD INJURY.

The valve will close when the shaft is released. The SAV is an LRU.

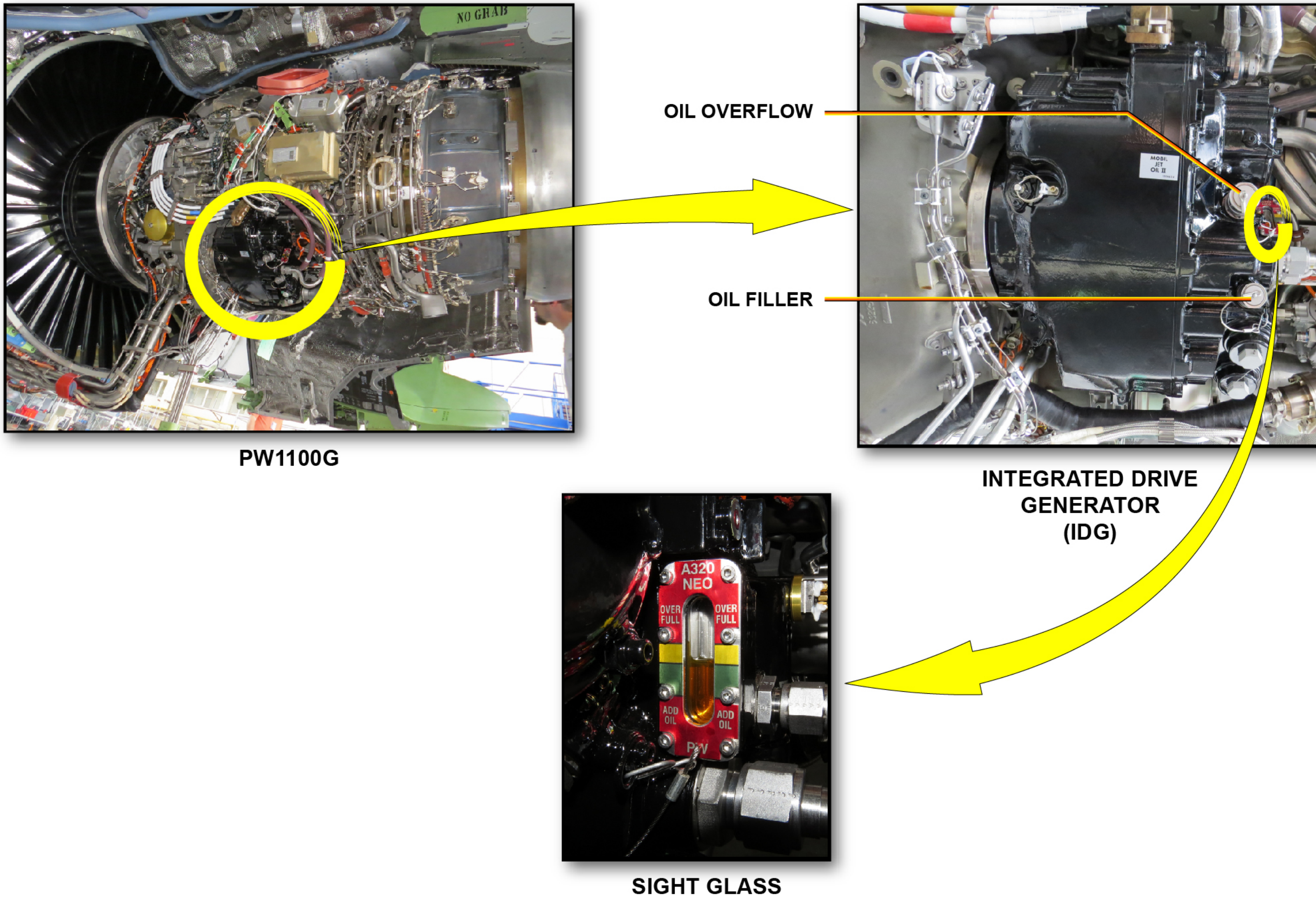


MEL / DEACTIVATION - START VALVE MANUAL OPERATION

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MAINTENANCE TIPS

For IDG servicing the left thrust reverser cowl-door has to be opened as the IDG installation change to core mounted area.
The IDG has two new additional sensors (oil level sensor and oil filter DPI) providing warnings IDG OIL LVL, IDG FILTER CLOG, which permit to increase the periodic inspection interval.
Follow the General Warnings and Cautions, related Safety Data and Standard Precautions for Maintenance Procedures.



MAINTENANCE TIPS

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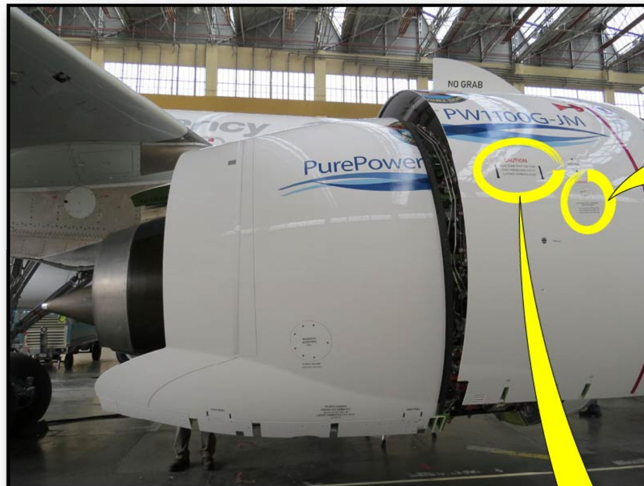

PW1100G

MAINTENANCE TIPS

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